016.53
P578
Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE INSTITUTE OF PHYSICS

THE AMERICAN PHYSICAL SOCIETY

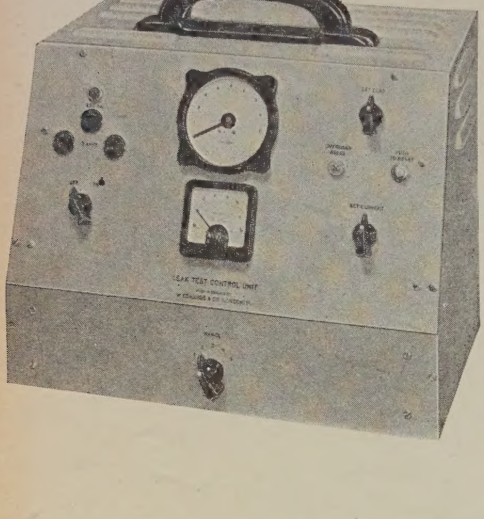
THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

Co-operating member of the I.C.S.U. Abstracting Board (International Council of Scientific Unions)

ABSTRACTS 6674–7615

VOLUME 58 **SEPTEMBER 1955** NUMBER 693

APPLYING *'Laboratory-Standard'* VACUUM LEAK TESTING . . .



Manufacturers requiring to locate leaks of the order approaching 10^{-2} lusecs★ down to 10^{-} lusecs★ can achieve this high standard of sensitivity speedily and economically with the aid of EDWARDS standard range of leak-detection instruments.

★ LUSEC, a leak term used to indicate a leakage equivalent to one cubic millimeter of air per second.

—*Industrially!*

—*Economically!*

SOME EXAMPLES OF THE EDWARDS RANGE INCLUDE

Model Lt. 2

Operates with EDWARDS Thermal-type vacuum gauge and a hydrogen probe. It is a highly sensitive device which quickly pin-points any leak approaching 10^{-2} lusecs.

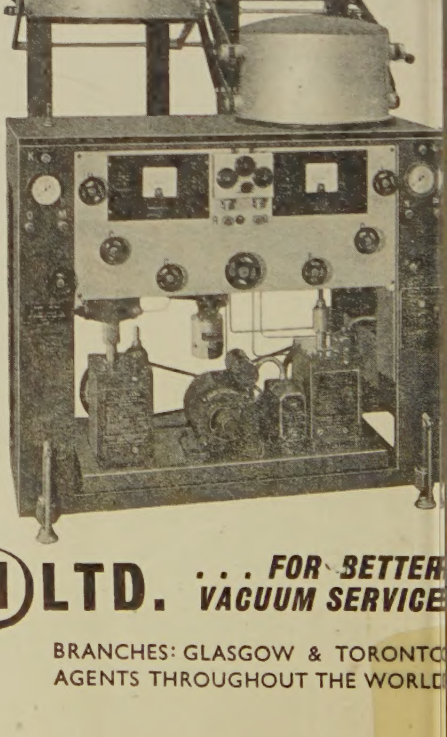
Palladium-Barrier Detector (top)

Pin-points leaks of the order 10^{-4} lusecs. Possesses a specific response to the tracer gas comparable to the mass-spectrometer and a sensitivity sufficient for the highest standards of vacuum tightness.

Battery-Operated Thermal Gauge (centre)

An EDWARDS precision Thermal-type vacuum gauge with integral highly sensitive leak detection facilities. (10^{-2} lusecs)

(*Below*) A special leak testing system designed for MORRIS MOTORS LTD.



EDWARDS HIGH VACUUM LTD. . . . ***FOR BETTER VACUUM SERVICE***

MANOR ROYAL · CRAWLEY · SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW & TORONTO
AGENTS THROUGHOUT THE WORLD

Principal Contents

SEPTEMBER 1955

		PAGE
51	MATHEMATICS	861
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	862
53	PHYSICS	865
530.1	Fundamentals	866
531	General mechanics. Mechanics of solids	872
531.7	Mechanical measurements	872
532	Mechanics of fluids	873
532.6	Capillarity	874
532.7	Molecular theory of liquids	874
533	Mechanics of gases	875
533.7	Molecular theory of gases	876
534	Vibrations. Acoustics	877
535	Optics. Radiation. Spectra	884
536	Heat	897
536.7/.8	Thermodynamics	900
537	Electricity	900
537.2	Electrostatics. Dielectrics	900
537.3	Electric conduction. Currents	902
537.52	Electric discharges	908
537.531	X-rays	912
537.533/.534	Cathode rays. Positive rays	912
537.54	Discharge tubes. Counters	917
537.56/.58	Ionization. Thermionics	919
537.591	Cosmic rays	921
538	Magnetism	922
538.3/.5	Electromagnetism. Electrodynamics	925
538.56	Electromagnetic waves and oscillators	925
539.1	Molecular and atomic structure	927
539.11	Theory of solid state	927
539.13	Molecules	929
539.15	Atoms. Nucleus. Isotopes	934
539.16	Radioactivity. α-, β- and γ-rays	939
539.17	Nuclear reactions	944
539.18	Atom and molecular beams. Mesons. Neutrons	948
539.2	Structure of solids	951
539.3/.8	Elasticity. Strength. Rheology	954
541	PHYSICAL CHEMISTRY	957
541.11/.12	Phase equilibrium. Chemical reactions	957
541.13	Electrochemistry	958
541.14/.15	Photochemistry. Radiation chemistry	960
541.18	Dispersions. Colloids. Adsorption	961
541.2/.6	Chemical structure	—
543/545	Chemical analysis	962
548	CRYSTALLOGRAPHY	963
548.7	Atomic and X-ray crystallography	965
55	GEOPHYSICS	970
551.5	Atmosphere. Meteorology	971
57/59	BIOLOGY	973
61	Medical science. Human physiology	973
62/69	TECHNIQUE. MATERIALS	976
77	Photography	976

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Lines and networks
Waveguides
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Oscillators. Pulse circuits
Amplifiers
Electroacoustic apparatus
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the Lists of Journals published with the January number of Volume 56 (1953) and the Supplements published with the Indexes to Volumes 56 (1953) and 57 (1954). Reprints of the List of Journals (1953) and the Supplements (1953 and 1954) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

New Journals

BBC Engng Monogr.	*BBC Engineering Division Monographs.* BBC Publications, 35 Marylebone High Street, London, W.1. Number 1 published June, 1955. Six will be produced every year. Individual copies 5s. post free; annual subscription £1 post free.
J. Electronics	*Journal of Electronics.* Taylor and Francis, Red Lion Court, Fleet Street, London, E.C.4; Academic Press, 125 East 23rd Street, New York 10, N.Y., U.S.A. Volume 1, Number 1, dated July, 1955. Price £1. Subscription per volume £5 10s. 0d. post free.

Notes

ACEC Rev.	*ACEC Revue.* Ateliers de Constructions Electriques de Charleroi, Rue Vital Francoisse, Marcinelle-Charleroi, Belgium. Formerly *Ateliers de Constructions Electriques de Charleroi* [*A.C.E.C. Charleroi*]. Change of title commencing No. 1, 1955.
Acta phys. Polon.	*Acta Physica Polonica.* Address changed to Institute of Physics of the Polish Academy of Sciences. Hoza 69, Warsaw, Poland.
Bol. Fac. Ingen. Montevideo	*Boletin de la Facultad de Ingenieria y Agrimensura de Montevideo.* Addition to title commencing Volume 6, Number 6.
Dædalus	*Dædalus.* New title for *Proceedings of the American Academy of Arts and Sciences* [*Proc. Amer. Acad. Arts Sci.*]; change of title commencing Volume 86, 1955.

Erratum

Abstr. 6311, line 2: *for* H. KORNETZKI *read* M. KORNETZKI.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 37 (1954): **122,** *No.* 1, 208 (*July*, 1955).
Abstr. 4102 (1954): **12,** *No.* 8, 385 (1955).
Abstr. 4768 (1954): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 10597 (1954): **23,** *No.* 7, 1374 (*July*, 1955).
Abstr. 11388 (1954): **98,** *No.* 6, 1871 (*June* 15, 1955).
Abstr. 1288 (1955): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 2125 (1955): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 2142 (1955): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 3090 (1955): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 3131 (1955): **98,** *No.* 6, 1870 (*June* 15, 1955).
Abstr. 3441 (1955): **12,** *No.* 6, 814 (*Dec.*, 1954).
Abstr. 3645 (1955): **12,** *No.* 8, 385 (1955).
Abstr. 4056 (1955): **98,** *No.* 6, 1871 (*June* 15, 1955).
Abstr. 4179 (1955): **98,** *No.* 6, 1871 (*June* 15, 1955).
Abstr. 4896 (1955): **98,** *No.* 6, 1871 (*June* 15, 1955).

MATHEMATICS 51

518.3 : 519.2

6674. The rank correlation method. J. T. LITCHFIELD, JR AND F. WILCOXON. *Analyt. Chem.*, **27**, *No.* 2, 299–300 (*Feb.*, 1955).

The usefulness of the rank correlation method has been increased by providing a table of critical totals for two levels of probability and a nomograph which gives the rank correlation coefficient directly. Use of the method is illustrated. A.

518.5

6675. Consideration of magnetic recording in the field of calculating machines. F. H. RAYMOND. *Onde élect.*, **35**, 89–96 (*Feb.*, 1955) In French.

The recording of information in binary form on drums to provide memory stores is studied. Non-contact heads are assumed and such points as the optimum thickness of magnetic coating and the shape of the magnetization curve along the track resulting from rectangular positive and negative magnetizing pulses are considered. The mechanism of both recording and reproducing is analysed, with particular reference to the effect of air-gap length on playback. The conditions demanded for enabling single recorded pulses or groups of pulses to be erased and altered are taken into account. For this form of recording pulse modulation is preferred.

H. G. M. SPRATT

518.5

6676. Simple electronic extrapolations of sampled data. T. Ž. ALEKSIĆ. *Bull. Inst. Nuclear. Sci. "Boris Kidrich,"* **5**, 37–42 (*March*, 1955).

Simple electronic circuits for extrapolation of sampled data are discussed. The method based on first differences formulae is found to be very convenient in proposed analogue technique. The circuit developed for generation of first differences can be used in the case of constant and variable sampling intervals. A.

518.5

6677. An electrostatic type of universal function generator. M. T. GOMIS GOMIS. *An. Real Soc. Españ. Fiz. Quim.*, **51(A)**, *No.* 3–4, 99–104 (*March–April*, 1955) In Spanish.

Twenty-four flat electrode plates were arranged in a circular tank of electrolyte with their normals tangential to the circumference. From a set of potentiometers each electrode was adjusted to an arbitrary alternating or direct voltage and a probe which dipped into the electrolyte could be rotated so as to pass in a circle near to each electrode in turn thus generating a voltage proportional to any required recurrent function. The solution which interpolates the voltage between the electrodes was varied and distilled water, which has a low conductivity, was found most suitable. A. L. MACKAY

518.5 : 536.2

6678. On the solution of the equation of heat conduction by means of electronic calculators. H. HARMUTH. *Acta phys. Austriaca*, **9**, *No.* 2, 90–8 (1955) In German.

The principle of Galton–Brett is explained and applied to the heat equation. It is an improvement on the Monte Carlo method. Both are essentially relaxation methods. The scheme is such that only a few preliminary calculations are needed, and then it is automatic. Its uses in one, two and three dimensions are illustrated. L. S. GODDARD

518.5 : 621.317.79 : 681.142

6679. Electrical analog computing machine for solving linear equations and related problems. S. K. MITRA. *Rev. sci. Instrum.*, **26**, *No.* 5, 453–7 (*May*, 1955).

A new iteration method of solving linear equations is described. The convergence of this method depends on a single scalar parameter which can be predetermined. A brief description of an electrical analogue machine for solving linear equations with 10 variables based on this iteration method is given. The machine gives also the largest eigenvalue of the matrix of the linear system. A.

518.5 : 681.142 : 621.374.4

6680. Function generators based on linear interpolation with applications to analogue computing. E. G. C. BURT AND O. H. LANGE. *Proc. Instn Elect. Engrs, Monogr. No.* 137 M, publ. *June*, 1955, 8 *pp.* [To be republished in *Part C.*]

The use of function generators in electronic analogue computing and simulation greatly extends the range of problems which can be solved by these methods. This paper presents a technique in which diode units are used to approximate to the functions by linear interpolation. It is shown that the method can be extended to deal with a wide class of functions, including multi-variate functions. Analogue multiplication and division are discussed as particular cases of function generators, and formulae for the general function are developed. The results are presented of an experimental generator for $\sin x$ in the range $-\pi \leqslant x \leqslant \pi$, in which the error is about $1\frac{1}{2}\%$ of the maximum output. A.

519.2

6681. The analysis of non-Markovian stochastic processes by the inclusion of supplementary variables. D. R. COX. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 433–41 (*July*, 1955).

Certain stochastic processes with discrete states in continuous time can be converted into Markov processes by the well-known method of including supplementary variables. It is shown that the resulting integro-differential equations simplify considerably when some distributions associated with the process have rational Laplace transforms. The results justify the formal use of complex transition probabilities. Conditions under which it is likely to be possible to obtain a solution for arbitrary distributions are examined, and the results are related briefly to other methods of investigating these processes. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.615

6682. Image converters with thin protecting foils. J. BURNS, III AND W. A. HILTNER. Note in *Astrophys. J.*, **121**, *No.* 3, 772–3 (*May*, 1955).

The use of a thin isolating wall of aluminium, or silicon monoxide, foil ~1 000 Å thick, to prevent rapid disintegration of the photocathode of the image convertor by water-vapour liberated from the photographic emulsion, is shown to be practicable. The cathode life is thereby extended from ~1 hour to >4 days. D. R. BARBER

522.617

6683. A proposal for a radial velocity photometer. P. FELLGETT. *Optica Acta*, **2**, *No.* 1, 9–16 (*April*, 1955).

It is uneconomical, both in telescope time and in labour of reduction, to observe the details of a stellar spectrum if the sole object of the observation is to measure a radial velocity. An application of information theory by Woodward and Davies has suggested ways of markedly reducing this inefficiency by correlation methods of observation. Three principal procedures are proposed. (*a*) The measurement of the position of a spectral line, recorded photographically by a microphotometer in which the transmission of the "slit" is made to agree with the expected shape of the line. (*b*) The measurement of radial velocity by superposing a photograph of the spectrum to be measured on that of a star of similar type having a known radial velocity. The overall transparency of the superposed spectra is measured as a function of relative shift in the direction of the dispersion, and compared with the corresponding variation for superposed comparison spectra recorded on the plates. The method may succeed with a weak spectrum recorded by a relatively short exposure on a suitably pre-fogged plate. (*c*) The direct measurement of radial velocity at the telescope by forming the spectrum of the star in a suitable spectrometer, into the focal plane of which can be placed a series of standard negatives of star spectra. The total transmission of the starlight through the appropriate negative is measured photoelectrically as a function of a displacement of the optical parts which simulates Doppler shift. The zero point of this shift is found in the same manner by superposing the spectrum of a comparison source on a comparison negative recorded alongside the standard star spectrum in the usual way. These methods, which give explicitly the probability distribution of radial velocity which results from the observations made, are shown to be in a certain sense ideal. A brief discussion is given of sensitivity and possible applications, particularly of method (*c*), for which the name radial velocity photometer is suggested. The theory may also have applications to astrometric measurements. A.

523.11

6684. Deductions from the perfect cosmological principle. J. W. DUNGEY. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 532–5 (*July*, 1955).

To obtain certain results of their perfect cosmological principle, Bondi and Gold made use of a part of the theory of kinematic relativity. The same results are here deduced directly from the perfect cosmological principle. A.

523.112

6685. The horizon of the steady-state universe. F. HOYLE. Letter in *Nature* [*London*] **175**, 808 (*May* 7, 1955).

A further clarification of the term "observable universe" as used in steady-state cosmology. See also Abstr. 5168–9 (1955). R. A. NEWING

523.12 : 536.7

6686. The problem of the applicability of the second law of thermodynamics to large objects in the universe. M. I. SHAKHPARONOV. *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11) 646–7 (1954) In Russian.

Discussion paper. The incorrectness of Ya. P. Terletskii's demonstration [see Abstr. 7878 (1952)] of the inapplicability of the second law of thermodynamics (confirming Boltzmann's fluctuation hypothesis) is shown. The attempt to base such a demonstration on methods of statistical thermodynamics (thus, implicitly, on the second law) involves an internal contradiction. Also, Terletskii's theoretical derivation leads to a result clashing with the principles of statistical thermodynamics, one of the fundamental assumptions of which (since Smoluchovskii's work in this field) is that fluctuations cannot upset the macroscopic equilibrium. By using the virial theorem it is then shown that the equations used in the derivation are incompatible. B. F. KRAUS

523.161

6687. The temperature of interstellar gas of high density. R. EBERT. *Z. Astrophys.*, **36**, *No.* 3, 222–9 (1955) In German.

Spitzer's calculations are extended to gas densities up to 10^6 H-atoms/cm^3, to discover the temperature–density relationship for H I regions. For dust-free gas, a constant temperature ~45°K is found for densities greater than 1 H-atom/cm^3. For gas with embedded dust, the temperature decreases slowly with increasing gas density to the internal temperature of the dust particles. M. W. OVENDEN

523.164

6688. Identification of cosmic sources of radio radiation with optical objects. H. H. VOIGT. *Naturwissenschaften*, **42**, *No.* 5, 115–19 (1955) In German.

A summary of published identifications.

M. W. OVENDEN

523.164

6689. The spatial distribution and the nature of radio stars. M. RYLE AND P. A. G. SCHEUER. *Proc. Roy. Soc. A*, **230**, 448–62 (*July* 12, 1955).

An investigation of the number-intensity distribution of the observed radio stars shows that they cannot be interpreted in terms of a homogeneous distribution of sources; there is an apparent increase in the spatial density or absolute luminosity of distant sources. It is also found that this increase is, within rather small statistical errors, independent of direction. It therefore appears that the solar system is situated at the centre of a spherical region in which the spatial

density or luminosity of the sources increases with distance, uniformly in all directions. It may also be concluded that this increase does not persist for distances much greater than those to which sources have been observed individually. It appears impossible to explain the results in terms of sources situated within the galaxy, or by irregular clustering of extragalactic sources. Furthermore, it may be shown from arguments based on the integrated radiation that the minimum radius of the spherical region is comparable with that of the optically observable universe. It is therefore suggested that the observed features are due to effects on a cosmical scale; such an explanation provides an immediate reason for the remarkably isotropic distribution of radio stars. Attempts to explain the observations according to steady-state theories offer little hope of success, but there seems every reason to suppose that they might be explained in terms of an evolutionary theory. No detailed comparison has yet been made between the observations and the predictions of any particular evolutionary model, but a general explanation of the observations seems possible if it is supposed that the majority of radio stars belong to an excessively rare class of object, having a local spatial density of about 2×10^{-26} parsec^{-3}, and an absolute luminosity comparable with that of the intense radio source in Cygnus. On this interpretation, the difficulty of identifying radio stars with optical objects finds a natural explanation; only some tens of the main class of radio star would be within reach of the 200 in. telescope. A.

523.165 : 537.591.1

6690. Astrophysical notes on the origin of cosmic radiation. A. Unsöld. *Z. Phys.*, **141**, *No.* 1–2, 70–82 (1955) In German.

A critical examination is made of various theories and it is concluded that the only tenable theory is one in which both cosmic rays and radiowave radiation originate in surges in highly turbulent magnetized plasma. It is suggested, therefore, that the radiation is generated in the atmospheres of numerous cool stars. R. A. NEWING

523.5

6691. Meteor radiation, ionization and atomic luminous efficiency. E. J. Öpik. *Proc. Roy. Soc. A*, **230**, 463–501 (July 12, 1955).

Meteor radiation consists predominantly of line emission, due to impact excitation of the meteor atoms. Recombination of atomic ions is another, probably minor source of radiation. Most of the molecules are broken up by collisions. Redistribution of charge effectively removes all ions of higher order whose ionization potentials exceed those of the atmospheric molecules. In the last stage of deceleration of an atomic ion it will have a fair chance of capturing a charge from an air molecule, without being able to become ionized again. Further, most of the ions are molecular, produced by redistribution of charge; their life-time is relatively short, as would correspond to radiationless dissociative recombination. It is shown that King's estimates of arc intensities should be used as straightforward intensities. Using the observed arc intensities for Fe I and Fe II, and approximate theoretical procedures for other atoms, luminous efficiencies in the photographic, visual and red regions of the spectrum, as well as in certain selected multiplets, are calculated for the excited states of atoms and ions which are common in meteors. It is found that meteor iron and stone possess practically the same visual luminous efficiency per unit mass, equal to 60% of the efficiency assumed in former publications of the writer. The coefficients of radiative attachment and luminous efficiencies in recombination are calculated for the more important ions, using an order-of-magnitude procedure. The absolute luminous efficiency per recombination is about 6 times greater than that per excitation of the neutral atom, the ratio being the same for iron as for stone. A.

523.59

6692. On the optical interpretation of the gegenschein. H. Siedentopf. *Z. Astrophys.*, **36**, *No.* 3, 240–4 (1955) In German.

An analogy is drawn between the gegenschein and the optical-meteorological phenomenon of the halo. This interpretation leads to estimates of the distribution function of the radii, of the albedo and of the number density of the interplanetary dust particles which are in good agreement with other estimates of these quantities. M. W. OVENDEN

523.72

6693. The variation of solar radio-frequency radiation on $\lambda = 10{\cdot}7$ cm in the 11-year solar cycle. M. Waldmeier. *Z. Astrophys.*, **36**, *No.* 3, 181–93 (1955) In German.

The variable component of solar radio emission on a wavelength of about 10 cm is supposed due to thermal emission of coronal condensations. The observed emission is compared with the sunspot relative number for the years 1947–1953. As the latter varies from 0 to 150, the component of emission from condensations associated with sunspots increases from 0 to 65 and the component from condensations free from spots from 0 to 48, in units in which the quiet-sun emission is 57. M. W. OVENDEN

523.72

6694. Evidence of limb-brightening of the sun at 60 cm wavelength. G. Swarup and R. Parthasarathy. *Observatory*, **75**, 8–9 (*Feb.*, 1955).

One-dimensional brightness distributions across the solar disk have been observed with the 32-element interferometer on 60 cm wavelength. The variable component was removed by superposition of individual distributions. Reductions on the assumption of circular symmetry, after partial removal of the smoothing effect of the aerial beam, yields a limb intensity about 50% higher than the central intensity.

M. W. OVENDEN

523.72

6695. The sun in two dimensions at 21 cm. W. N. Christiansen and J. A. Warburton. *Observatory*, **75**, 9–10 (*Feb.*, 1955).

Two independent aerial systems, one having high resolution in the E–W plane, and the other high resolution in the N–S plane, have been used to obtain one-dimensional brightness distributions across the solar disk over a wide range of angles with respect to the solar axis of rotation. From such scans, a two

dimensional brightness distribution has been derived. The distribution shows quadrant symmetry, with isophotes flattened at the poles, and limb-brightening confined to angles $\pm 60°$ from the equator.

M. W. OVENDEN

523.72

6696. Distribution of radio-frequency brightness across the solar disk at a wavelength of 60 cm. P. A. O'BRIEN AND E. TANDBERG-HANSSEN. *Observatory*, **75**, 11–13 (*Feb.*, 1955).

Interferometers with axes inclined at various angles to the solar axis of rotation were used. The observations indicate rotational symmetry. Reduction with this assumption shows departure from circular symmetry in the sense of greater equatorial extension. Limb-brightening occurs, with a peak brightness at $0{\cdot}6R_{\odot}$. There is evidence of a change in the brightness distribution during the sunspot cycle.

M. W. OVENDEN

523.72

6697. A solar noise outburst of January 15, 1955. T. R. HARTZ. Letter in *Nature* [*London*] **175**, 908–9 (*May* 21, 1955).

Four exceptional bursts of solar noise recorded with an interferometer-type receiver at a frequency of 50 Mc/s during the period January 15–19, 1955 are correlated with intense ionospheric disturbance from Jan. 17 to 20, and with bright aurorae during the nights of Jan. 17, 18 and 19. D. R. BARBER

523.72 : 550.385 : 551.594.5

On the emission of electric currents from the sun. *See Abstr.* 7564

523.74

6698. The integral equation of darkening from the centre to the limb of the sun. J. WARZÉE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41**, *No.* 2, 106–37 (1955) In French.

The integral equation of limb-darkening $I(\mu) = \int_0^{\infty} e^{-\tau/\mu} B(\tau) \frac{d\tau}{\mu}$ is solved by putting $B(\tau) = a_0 + a_1\tau - q(\tau)$, with

(*a*): $q(\tau) = \alpha_1 e^{-\tau} + \alpha_2 e^{-2\tau} + \alpha_3 e^{-3\tau} \ldots (\tau \geqslant 0{\cdot}2)$ or $q(\tau) = \alpha_2 e^{-2\tau} + \alpha_4 e^{-4\tau} \ldots (\tau \geqslant 0{\cdot}2)$ and

(*b*): $q(\tau) = \beta_0 + \beta_1\tau\log\tau + \beta_2(\tau\log\tau)^2 + \ldots (0 \leqslant \tau \leqslant 0{\cdot}2)$.

The equation of continuity and the normalizing condition $I(1) = 1$ reduce the variables to three, which can be solved by least squares from equations of condition in μ. A critical discussion of the methods of Milne–Lindblad, Busbridge and Sykes is followed by an application of the above method to observations of the solar disk at $\lambda 5485$. M. W. OVENDEN

523.74 : 537.591.5

6699. Association of a "unipolar" magnetic region on the sun with changes of primary cosmic-ray intensity. J. A. SIMPSON, H. W. BABCOCK AND H. D. BABCOCK. *Phys. Rev.*, **98**, *No.* 5, 1402–6 (*June* 1, 1955).

A new instrument for observing weak magnetic fields on the photosphere of the sun has recently revealed the presence of an unusual area on the solar surface which may be called a "unipolar" magnetic (UM) region because the field is of one sign and no magnetic flux has been found returning to the sun. A region of this type was observed at central solar meridian on seven consecutive solar rotations in 1953. In the present paper it is shown that there is a striking association of this UM region with (1) times of maximum primary cosmic-ray intensity as measured by neutron detectors and an ionization chamber, and with (2) the recurring geomagnetic storms—the geomagnetic disturbances being most pronounced ~3–4 days after both the central meridian passage of the UM region and the time of maximum cosmic-ray intensity. A.

523.746

6700. Investigations into the group formation of sunspots. U. BECKER. *Z. Astrophys.*, **37**, *No.* 1, 47–66 (1955) In German.

The *Greenwich Photoheliographic Results*, covering solar cycles 12–17 (1879–1944) have been used in this statistical study. For 46 long-lived formations (up to 21 successive rotations) a forward drift of between 2 and 3 degrees per solar rotation is found. During the lifetimes of such long-lived formations new individual spots appear within the group structure.

D. R. BARBER

523.75

6701. Photometry of prominences with the coronograph. L. OSTER. *Z. Astrophys.*, **36**, *No.* 3, 212–21 (1955) In German.

A method of simultaneous recording of standard intensity marks on prominence photographs taken with the coronograph is described, the method being applied to the construction of isophotes for three prominences. Various sources of error are discussed.

M. W. OVENDEN

523.75 : 532.5 : 538.56

6702. Magneto-hydrodynamic waves and solar prominences. H. ALFVÉN. *Indian J. Meteorol. Geophys.*, **5**, *Special No.*, 133–6 (*Dec.*, 1954).

It is suggested that when the wave front reaches the solar surface, part of the disturbance moves towards the equator, producing sunspots, and part toward the pole, this latter part producing the high-latitude prominence activity. An extension of sunspot progression curves to higher latitudes gives satisfactory representations of maximum prominence activity.

R. A. NEWING

523.77

6703. The yellow emission line of the solar corona. D. LAYZER. Letter in *Nature* [*London*] **175**, 647–8 (*April* 9, 1955).

The coronal lines $\lambda\lambda 5694$ and 5445 have been identified by Edlen and Waldmeier as due to the transitions $2p^2\,{}^3P_{1\to 0}$ and $2p^2\,{}^3P_{2\to 1}$ in Ca XV. A theoretical analysis by Garstang [Abstr. 2918, 8643 (1952)] yielded wavelengths of $\lambda\lambda 5480$ and 5380 for these transitions. Garstang's analysis is refined by the inclusion of effects of configuration mixing when spin-dependent interactions are important. The new predicted wavelengths are $\lambda\lambda 5650$ and 5456, the improved agreement tending to confirm the identifications. M. W. OVENDEN

523.77

6704. Calculation of the equivalent widths of the Balmer lines: application to the solar case. C. PECKER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1860–2 (*May* 9, 1955) In French.

Theoretical curves of growth have been computed

for the solar Balmer lines, using a model suggested by Barbier (1946) and embodying the Milne–Eddington approximation. Two types of curve, supposing widening due to (I) ions and electrons, and (II) by ions only, are compared with the experimental data of de Jager (1952). Curve I is found to yield a best fit with observation. D. R. BARBER

523.851.1

6705. Is there a statistical mechanics of stellar systems? R. KURTH. *Z. angew. Math. Phys.*, **6**, *No.* 2, 115–25 (1955) In German.

It is claimed that it is not possible to find a non-negative normalizable first integral of the equations of motion that could be used to define a probability density in phase space. The applicability of statistical mechanics to stellar systems is questioned. R. A. NEWING

523.877

6706. Blended multiplets in stellar atmospheres. W. PRIESTER. *Z. Astrophys.*, **36**, *No.* 3, 230–9 (1955) In German.

It is pointed out that, for stars with "normal" spectra, selective fluorescence will result from the coincidence of a member of a multiplet series of one element with a strong line of another element: the distribution of the energy levels in question will not be markedly affected by the interaction. This effect, and its influence on the growth-curve of the blended multiplet, has been investigated for five near-coincidences found in the spectra of the solar photosphere, chromosphere, and 15 stars, types *A* to *M*. D. R. BARBER

523.877

6707. The intensities of blended absorption lines in stellar atmospheres. W. BAUER. *Z. Astrophys.*, **37**, *No.* 1, 1–46 (1955) In German.

A study of the effects of "blends" on the undistorted profiles of certain absorption lines using: (1) Milne–Eddington; and (2) Schuster–Schwarzschild stellar models. The "blend effect" for 20 metallic lines in the wings of the solar *H* and *K* lines of Ca has been measured, and compared with the corresponding value computed from theoretical line-contours. Comparison between theory and observations indicates an enhancement of ionization temperature at the higher photospheric levels. D. R. BARBER

523.877

6708. Equivalent line-widths on the hypothesis of a Schuster–Schwarzschild model. J.-C. PECKER AND H. VAN REGEMORTER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1857–9 (*May* 9, 1955) In French.

New, and more accurate curves of growth, based on this model, are constructed which differ materially from those computed by the approximate method of Menzel (1936). The latter are in agreement only when considering either very weak or very strong lines. D. R. BARBER

523.877

6709. Correlation curves in the Schuster–Schwarzschild hypothesis. H. VAN REGEMORTER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1968–9 (*May* 16, 1955) In French.

Numerical values of macro- and micro-turbulence, computed with the aid of the S.-S. stellar model, are markedly altered when corrections deduced from the generalized formulae for absorption line growth-curves developed by Pecker are applied to the theoretical curves of correlation. D. R. BARBER

523.877

6710. The temperature of excitation for strong and weak lines. H. VAN REGEMORTER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2053–5 (*May* 23, 1955) In French.

Although for weak stellar lines, the excitation temperature may be defined in terms of a parameter related to the mean surface temperature for a star, this is not so when intermediate, and strong lines are considered. The excitation temperature under these conditions now depends on the oscillator strengths, gf_0 and gf_1 in a complex manner determined by the actual line strength. D. R. BARBER

523.877 : 538.561

Plasma oscillations in an external magnetic field. *See Abstr.* 7206

PHYSICS 53

53.081

6711. On empirical and arbitrary bases of units and unit-systems. E. LANGE. *Z. phys. Chem.* [*Leipzig*] **204**, *No.* 3–4, 245–58 (*May*, 1955) In German.

The general relations between physical quantities, numerics, units and dimensions are derived and discussed. S. WEINTROUB

53.083.5 : 621.317.7.083.5

6712. A photoelectric compensator with good zero stability. A. KELEN. *Appl. sci. Res. B*, **4**, *No.* 4, 285–8 (1955)

A laboratory-made apparatus for long-time recording of small voltages is described. Care is taken to reduce zero-drift. Construction and adjustment of the equipment are discussed. A.

53.083.5 : 621.317.7.083.75

6713. On the theory of photoelectric compensators and their accuracy. A. KELEN. *Appl. sci. Res. B*, **4**, *No.* 4, 278–84 (1955).

A description of the operating principles of photoelectric compensators is given. Formulae characterizing the behaviour of measuring systems with partial compensation are derived. A comparison is made with systems without compensation or without restoring force. The influence of spontaneous thermal fluctuations on measuring accuracy is analysed. It is shown that a device with partial compensation in this respect is inferior to one without compensation. Figures given show the order of measuring accuracy. A.

53.088

6714. The correction of observational data for instrumental band width. F. D. KAHN. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 519–25 (*July*, 1955).

The readings $\phi(x)$ of an instrument with the

apparatus function $g(x)$ are related to the true values $f(x)$ of the observed function by the equation $\phi(x) = \int_{-\infty}^{\infty} g(u)f(x-u)du$. A three-point interpolation operator can be chosen to simulate the spreading action of a class of functions $g(x)$. Under certain conditions the interpolation operator has an exact inverse which, when applied to $\phi(x)$, gives a function which is a better approximation to $f(x)$. The accuracy obtained is discussed, and the effect of the method on the standard errors in the measurement is found. A.

FUNDAMENTALS 530.1

530.1

6715. The concept of order. II. Measurements. E. W. BASTIN AND C. W. KILMISTER. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 454–68 (*July*, 1955).

For Pt I, see Abstr. 4147 (1954). From the idea of the continuous development of an investigation, as expressed in the use of indefinitely continuing sequences of procedures, the concept of a measurement together with its result is formulated. The resulting theory is initially very general, but it is possible to restrict it in such a way as to make the construction of a consistent world possible. The physical condition providing the restrictions that make this construction possible is found in the use of the general idea of a test-particle in all fundamental investigations, which is shown to be a case of the use of the theory-languages of Pt I. Finally, the theory is applied to the solution of the problem of preferred inertial frames. A.

530.1 : 517.11

6716. Physics and mathematical logic. U. FARINELLI AND A. GAMBA. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1152–8 (*June*, 1955).

The possibility of application of mathematical logic to the investigation of physical problems is discussed; the basic elements of mathematical logic are introduced and examples are given. A.

530.112

6717. A new æther-drift experiment. L. ESSEN. *Nature* [*London*] **175**, 793–4 (*May* 7, 1955).

Details are given of an experimental investigation of the fluctuations in the frequency of an oscillator controlled by a rotating cylindrical cavity resonator. It is concluded that the drift effect, if any, must be less than one-tenth that reported by Miller (1933).

R. A. NEWING

530.12

6718. Tensor analysis and Lamé metrics. YU. B. RUMER. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 271–81 (1953) In Russian.

A systematic representation of the special type of tensor analysis used by the author in his papers on 5-optics is presented. This special type of tensor analysis is required because the spinor concept cannot be introduced into Riemann space without abandoning the classic methods of investigation in Riemann's geometry. The first suggestion to overcome this difficulty by using Lamé's rather than Gauss's coefficients in introducing the metrics was made by Fok (1929). Author shows that the primary geometrical forms defining the metrics of the Riemann space are actually the elements of the Lamé metric matrix, whereas the components of the metric tensor g_{ik} are derived quadratic forms. Where ordinary tensors are required which are spin-tensors of even rank, the usual metrics finds application. Where, however, spin-tensors of un-even rank occur, Lamé metrics is required. The system of tensor analysis presented is based on these considerations and deals with, *inter alia*, covariant and invariant tensor differentiation, the relation between Ricci symbols and Lamé's metric tensor, Riemann's tensor and spinors in the Riemann space, and with invariant Hilbert integrals. B. F. KRAUS

530.12

6719. On six-dimensional unified field theories. K. YANO AND M. OHGANE. *Univ. Roma Ist. Naz. Alta Mat. Rend. Mat. e Appl.* (*Ser.* 5) **13**, 99–132 (1954).

Previously it was proved that all geometries appearing in 5-dimensional unified field theory are special cases of the geometry of a V_5 (5-dim. Riemannian space) in which a vector field is given. The same is now proved for 6 dimensions.

MATHEMATICAL REVIEWS

530.12

6720. On the equations of motion of a system of finite masses in Einstein's theory of gravitation. V. P. KASHKAROV. *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11) 563–70 (1954) In Russian.

Fok's approximation method of solving Einstein's equation $R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -\kappa T_{\mu\nu}$ [V. A. Fok, *Zh. éksper. teor. Fiz.*, **9**, 375 (1939)] is generalized to the case of finite masses, not necessarily spherical. It is shown that the equations of motion follow from the field equations, both for translations and rotations.

W. J. SWIATECKI

530.12

6721. Algebraic properties of the field in the relativistic theory of the asymmetric field. A. EINSTEIN AND B. KAUFMAN. *Ann. Math.*, **59**, 230–44 (1954).

In the theory of the non-symmetric field it is necessary for the signature of the field to be constant throughout space. It is shown that the condition for this is a consequence of two postulates.

MATHEMATICAL REVIEWS

530.12

6722. On the relativistic equations of motion of a particle subject to a force derived from a scalar potential. G. M. PROSPERI. *R.C. Accad. Naz. Lincei*, **18**, *No.* 1, 69–74 (*Jan.*, 1955) In Italian.

The equations proposed are the same as those already introduced by Marx and Szamosi [Abstr. 4341 (1955)]. It is noted that the equations can be derived from a variational principle and that they can be regarded as the classical limit of relativistic wave equations. R. A. NEWING

530.12

6723. On a generalization of the relativistic dynamics of a particle. F. DUIMIO. *R.C. Accad. Naz. Lincei*, **18**, *No.* 1, 75–8 (*Jan.*, 1955) In Italian.

Equations of motion are derived from a variational principle in which the Lagrangian is regarded as a

function of the 5 variables x^μ, τ/m_0, τ being proper time and m_0 the rest mass. A particular choice of Lagrangian gives motion in an electromagnetic field together with a scalar field inversely proportional to the rest mass. The action of the scalar field is equivalent to motion with variable rest mass.

R. A. NEWING

530.12

6724. On the spherical symmetry of a tensor of rank 2. G. BERTHÉ. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1313–14 (*March* 21, 1955) *In French.*

A new criterion for spherical symmetry leads to expressions for g_{ik} similar to those given by Vaidya [Abstr. 4591 (1953)]. R. A. NEWING

530.12 : 523.112

6725. On the cosmological implication of galactic magnetic fields. R. L. BRAHMACHARY. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 953–4 (*May*, 1955).

A spherically symmetric solution of the field equations is obtained for a magnetic monopole. The solution is to be used to investigate the effect of the presence of a magnetic field in model universes.

R. A. NEWING

530.12 : 538.3

On Langevin's formulation of the concepts and laws of the electromagnetic field. *See Abstr.* 7203

530.145

6726. The principle of continuity and quantum theory. A. LANDÉ. *J. Phys. Radium*, **16**, *No.* 5, 353–7 (*May*, 1955) *In French.*

The concepts and formal rules of quantum theory are set up on the basis of simple physical postulates, with particular emphasis on probability considered as an essential idea in modern physics. Continuity of entropy is postulated and this leads to most of the results, such as those on the superposition of amplitudes. For more details see the author's monograph *Foundations of Quantum Theory, a Study in Continuity and Symmetry* (Yale and Oxford, 1955).

L. S. GODDARD

530.145

6727. The correlation function of a quantum variable. Y. AYANT. *J. Phys. Radium*, **16**, *No.* 5, 411–16 (*May*, 1955) In French.

The function is defined, relative to a Gibbs ensemble, and some of its properties are developed [see Abstr. 6260 (1954)]. Application is made to the theory of nuclear magnetic resonance in liquids [Abstr. 8495 (1954)]. L. S. GODDARD

530.145

6728. Convergent series expansions and singular potentials in quantum field theory. I. W. GÜTTINGER. *Z. Naturforsch.*, **10a**, *No.* 4, 257–66 (1955) In German.

The concept of a pseudofunction [see Abstr. 2938 (1953)] is shown to lead to convergent series expansions, which would diverge in ordinary perturbation theory. Several examples are discussed: infrared divergences, expansion of bound states in terms of the coupling constant. Finite Fourier transformations for singular potentials, such as $\exp(-\alpha r)/r^n$, are derived. An iteration method is applied to some integral equations occurring in field theory. G. FIELD

530.145

6729. General theory of propagators. H. UMEZAWA AND A. VISCONTI. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1079–103 (*June*, 1955).

A general theory of propagators is developed. All propagators are derived from a generating functional. Renormalization corresponds to the adjustment of the coupling constants of the external sources. As an example, renormalized equations for Compton and Møller scattering are derived. [For shorter version see Abstr. 1506 (1955).] A.

530.145

6730. Space and time reflection of observable and non-observable quantities in field theory. G. MORPURGO AND B. F. TOUSCHEK. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1159–79 (*June*, 1955).

The definition of time reversal [Abstr. 711 (1955)] based only on the transformation properties of one-particle observables is extended to the case of space reflection and put on a basis in which no preference is given to the momentum set of occupation numbers. This considerably restricts the class of the *F*-functions, with the effect that for a reversible system of fields the observables transform in a definite way while the non-observables do not. The formalism is applied to the problem of fermion types. It is shown that the exclusion of the interactions leading to the loss of heavy particles cannot be justified by an assignment of types to the fermions. A.

530.145

6731. Theory of half-quantized systems. H. KOPPE. *Z. Phys.*, **141**, *No.* 1–2, 103–10 (1955) In German.

An attempt to quantize only some, but not all, of the dynamical variables meets, not surprisingly, with difficulties. W. A. HEPNER

530.145

6732. Quantization of the electromagnetic field in a new type of representation. P. ROMÁN. *Acta phys. Hungar.*, **4**, *No.* 3, 209–18 (1955) In German.

After reduction of the scalar field to give the Coulomb energy, the two transverse components of the electromagnetic field can be expressed in terms of one complex quantity. Equations are simple in terms of this quantity. G. E. BROWN

530.145

6733. Birefringency in non-linear electrodynamics. V. I. SKOBELKIN. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 677–89 (1954) In Russian.

It is shown that among all the non-linear systems of electrodynamics that of Born–Infeld is the only one in which birefringency is absent in directions normal to the collinear electromagnetic fields. It is also shown that the light may, in a non-linear electrodynamics, in general be resolved into four components linearly polarized in four different planes. B. F. KRAUS

530.145

6734. A generalization of the regular solution of Einstein's gravitational and Maxwell's electromagnetic equations for a point charge. DUAN' I-SHI. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12), 756–8 (1954) In Russian.

This generalized solution is used to compute the self-mass of the particle. J. M. RADCLIFFE

530.145

6735. On the definition of an infinitesimal group of gauge transformations in electrodynamics. D. RIVIER. *Arch Sci.* [*Geneva*] **8**, *No.* 1, 79–82 (1955) In French.

Brief announcement of results given more fully elsewhere. See Abstr. 2404 (1955). J. S. BELL

530.145

6736. The derivation of the relativistic electrodynamics of the vacuum from the model energy quantum. H. ZUHRT. *Arch. elekt. Übertragung*, **9**, *No.* 1, 47–51 (*Jan.*, 1955) In German.

A derivation of the transformation formulae for the field intensities is based on the author's model quantum [Abstr. 3536 (1955)]. R. A. NEWING

530.145

6737. Multiple photon production in quantum electrodynamics. S. N. GUPTA. *Phys. Rev.*, **98**, *No.* 5, 1502–11 (*June* 1, 1955).

Multiple production of photons in high-energy processes in quantum electrodynamics is investigated, and the electron-positron annihilation is specially discussed in detail. It is found that at very high energies in cosmic rays, multiple production of up to four or five observable photons can easily take place. But the probability, according to quantum electrodynamics, for the multiple production of a larger number of observable photons is quite small. A.

530.145

6738. The eigenvalues of the charge operator. E. KARLSON. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 382–9 (*June* 21, 1955).

It is shown without using perturbation theory that, if charge renormalization is defined in the usual way, the charge operator has the eigenvalue $e(n_- - n_+)$ for a state corresponding to n_- incoming electrons, n_+ incoming positrons, and an arbitrary number of incoming photons. It is also shown that, in the special case of one incoming electron and no other incoming particles, this leads to the statement that the radiative corrections to the Rutherford formula for the scattering in a weak external field vanish in the non-relativistic limit. A.

530.145

6739. Unitary transformations and spinor calculus. L. INFELD AND J. PLEBAŃSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 2, 95–9 (1955).

Consideration of the linear transformations which leave the commutation relations invariant leads to an application of the spinor calculus [see Abstr. 1036 (1954)]. Also, by considering the unitary operators as inducing linear unimodular transformations for spinors, one reaches the formalism of the 4-dimensional Minkowski space. The main mathematical ideas of this theory are presented. L. S. GODDARD

530.145

6740. Elementary particles and composite particles. E.-C.-G. STUECKELBERG AND G. WANDERS. *Arch. Sci.* [*Geneva*] **8**, *No.* 1, 71–9 (1955) In French.

A modification of the Bethe–Salpeter two-body equation is proposed to take account of the interaction of one of the particles with an external field. Thus a covariant description can be given of processes such as the photo-disintegration of the deuteron. A simplified version of the theory is worked out. The results differ from those of a non-relativistic approach by terms attributed to the intervention of anti-particles and "pseudoquanta." J. S. BELL

530.145

6741. Non-relativistic equation for particles with spin 1. J. J. GIAMBIAGI AND J. TIOMNO. *An. Acad. Brasil. Ciênc.*, **26**, *No.* 2, 327–34 (1955).

The method of Foldy and Wouthuysen [Abstr. 5526 (1950)] is extended to the case of spin 1 particles and the equation for their interaction with the electromagnetic field is obtained up to terms of order $1/m^2$. The Hamiltonian is shown to contain no terms of order $1/m^2$, such as spin-orbit coupling or quadrupole interaction. G. FIELD

530.145

6742. Properties of Dirac matrices. R. H. GOOD, JR. *Rev. mod. Phys.*, **27**, *No.* 2, 187–211 (*April*, 1955).

The elementary properties of these matrices are well known, but some of the current applications of Dirac's theory are based on some of the lesser known theorems. The purpose of the paper is to give a consistent and reasonably complete account of the properties of these matrices. The discussion is limited to four-by-four matrices, and the treatment follows closely the work of Pauli.

530.145

6743. New relativistic two-body equation. V. GLASER. Letter in *Phys. Rev.*, **98**, *No.* 3, 840 (*May* 1, 1955).

A quantity of the type $\langle \text{out}|O(x)|\text{in}\rangle$ is introduced, where $O(x)$ is a Heisenberg operator, $|\text{in}\rangle$ and $|\text{out}\rangle$ states of incoming and outgoing particles respectively. The equation satisfied by such a quantity is derived for the case of two Dirac fields, interacting through a pseudoscalar field, and its properties discussed. G. FIELD

530.145

6744. Projection operator for the Rarita–Schwinger equation. F. J. MILFORD. *Phys. Rev.*, **98**, *No.* 5, 1488 (*June* 1, 1955).

An operator which removes the spin one-half states from an arbitrary Rarita–Schwinger type state function has been constructed. This procedure avoids the explicit construction of spin three-halves state functions and makes possible the use of the Casimir spur technique for handling sums over spin three-halves states. A.

530.145

6745. On the general theory of particles of given spin and the problem of infinite self energies. R. POTIER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 14, 1512–14 (*April* 4, 1955) In French.

An extension of previous work [Abstr. 5938 (1949)], in which now an infinite set of wave-functions is considered. The interaction of particles with the electromagnetic field is dealt with. G. FIELD

530.145

6746. A picture of the electron. M. BUNGE. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 977–85 (*June*, 1955).

It is shown that, without performing a Foldy–Wouthuysen transformation, a position operator with a smooth motion can be defined for Dirac's electron. This mean-position operator may be interpreted as the centre-of-mass operator. It is further shown that

the vector product of the new mean-position operator by the kinetic momentum yields a tensor of mean-angular momentum, the 6 components of which are constants of the motion of the free electron. The equation of motion of the mean-angular momentum in the presence of an external field is shown to be the analogue of the classical torque equation. It is suggested that these results may be interpreted as showing that, while the electron's charge is concentrated at point x, the electron's mass is spread over a region of dimensions of a Compton wavelength, this volume being the seat of well-known microcurrents associated with the intrinsic magnetic and electric moment. The advantages of this mixed picture of the electron over the point-particle model and over the extended-source model are discussed. A.

530.145

6747. On non-local form factors. R. J. FINKELSTEIN. *Nuovo Cimento* (*Ser.* 10) **1,** *No.* 6, 1113–19 (*June*, 1955).

A non-local formalism is suggested for relating classical ideas about unitary fields with the current methods of making calculations about elementary particles. In the proposed scheme the form factors and masses of all particles are obtained from a single invariant through a classical Lagrangian principle. A.

530.145

6748. Conservation of heavy particles and generalized gauge transformations. T. D. LEE AND C. N. YANG. *Phys. Rev.*, **98,** *No.* 5, 1501 (*June* 1, 1955).

The possibility of a heavy-particle gauge transformation is discussed. A.

530.145 : 538.566

6749. Diffraction of the ψ_n waves of the Dirac electron. PHAN-VAN-LOC. *Ann. Fac. Sci. Univ. Toulouse*, **18,** 178–92 (1954; publ. 1955) In French.

In order to apply Huyghen's principle to the ψ-waves a generalized Kirchhoff formula is derived and used to discuss the diffraction of plane waves by a semi-infinite plane and by a slit. Spherical waves are also considered. R. A. NEWING

530.145

6750. On the modified Tamm method. V. P. SILIN. Letter in *Zh. éksper. teor. Fiz.*, **27,** *No.* 6(12), 754–6 (1954) In Russian.

Treats the renormalization of the lowest approximation to the modified covariant Tamm–Dancoff equations for a nucleon and a pseudoscalar meson with pseudoscalar coupling. J. M. RADCLIFFE

530.145

6751. Meson theoretical potentials in triplet odd state. S. OTSUKI AND R. TAMAGAKI. Letter in *Progr. theor. Phys.*, **12,** *No.* 6, 806–8 (*Dec.*, 1954).

Low-energy p–p experiments [Abstr. 6096 (1953)] show that a combination of P phase shifts $\Delta = (1/9)(\delta_0^1 + 3\delta_1^1 + 5\delta_2^1)$ is negative. This can be explained by potentials from symmetrical pseudoscalar meson theory. G. E. BROWN

530.145

6752. A remark on convergence factor. N. ITO. Letter in *Progr. theor. Phys.*, **12,** *No.* 6, 809–10 (*Dec.*, 1954).

The self-energy of the electron is calculated using a convergence factor arising from the "cohesive" meson theory. G. E. BROWN

530.145

6753. A classical treatment of the scattering of electromagnetic waves by nucleons. I. SATO AND Y. ICHIKAWA. Letter in *Progr. theor. Phys.*, **12,** *No.* 6, 812–14 (*Dec.*, 1954).

Using the technique of Bruecker and Case [Abstr. 8525 (1951)], one assumes spin and isotopic spin of the nucleon to be classical vectors and an unquantized meson field. The equations are solved to order e^2 in the coupling constant. A cutoff must be introduced. G. E. BROWN

530.145

6754. Saturation of nuclear forces in the non-linear pseudoscalar meson theory with vector coupling. Y. AHMAVAARA AND P. JAUHO. *Ann. Acad. Sci. Fennicae AI, No.* 184, 13 *pp.* (1955).

A non-linear pseudoscalar meson theory with vector coupling is investigated. It is shown that owing to the non-validity of the superposition principle, the presence of a non-linear term in the equation for meson amplitude leads even in this case to a saturation property for nuclear forces. Extended source nucleons and the classical field theory are used throughout the paper. A.

530.145

6755. On the question of unitarity of the S-matrix in the quantum theory of fields with non-local interaction. B. V. MEDVEDEV. *Dokl. Akad. Nauk SSSR*, **100,** *No.* 3, 433–5 (1955) In Russian.

The three-point vertex interaction proposed by Bloch [Abstr. 2197 (1953)] leads to a unitary S-matrix at least as far as 4th-order processes if one symmetrizes with respect to charge. Hayashi [Abstr. 5277 (1954)] found it to be non-unitary, but he used an unsymmetrized interaction. G. E. BROWN

530.145

6756. "Equivalent" potentials for the motion of the nucleon in pseudoscalar fields. J. WERLE. *Bull. Acad. Polon. Sci. Cl.* 3, **3,** *No.* 2, 87–90 (1955).

The static approximation for the nucleon–nucleon potential due to direct symmetric coupling with pseudoscalar mesons is derived. P. T. MATTHEWS

530.145

6757. Theory of scattering in a quasi-classical approximation. I. I. GOL'DMAN AND A. B. MIGDAL. *Zh. éksper. teor. Fiz.*, **28,** *No.* 4, 394–400 (1955) In Russian.

The wave-function is represented as $\psi = \psi_0 + \psi_1$ where ψ_0 is the semi-classical (W.K.B.-like) function $\sum_\lambda A'_\lambda e^{iS\lambda}$. The equation on ψ_1 is then $\Delta\psi_1 + k^2(r)\psi_1 = -\sum_\lambda \Delta A'_\lambda e^{iS\lambda}$. Approximate solutions are found for using a semi-classical Green function. G. E. BROWN

530.145

6758. Charge independence in nuclear physics. R. E. MARSHAK. *J. Phys. Radium*, **16,** *No.* 4, 325–34 (*April*, 1955) In French.

A review article which gives the experimental facts and their theoretical interpretation, leading to the postulate of the charge independence of nuclear forces. It includes discussion of: energy levels of light nuclei; high-energy nucleon–nucleon scattering; π-mesons (scattering on nucleons, production in nuclei, photoproduction). G. FIELD

530.145

6759. Meson pair theory. A. KLEIN AND B. H. MCCORMICK. *Phys. Rev.*, **98**, *No.* 5, 1428–45 (*June* 1, 1955).

A comprehensive treatment of meson pair theory is presented from the point of view of the Møller scattering matrix and the *S*-matrix. First, the solutions of the classical field equations are used to exhibit the Heisenberg operator for the meson field in terms of the "in" operator of Yang and Feldman. The orthogonality and completeness of this set of one-particle scattering functions is demonstrated. Both the Møller matrix and the *S*-matrix are constructed explicitly as ordered operators by taking advantage of the fact that they generate known linear transformations. Schwinger's dynamical principle is used both for these purposes and to find the nucleon self-energy. Explicit proofs of the unitarity of the scattering matrices are given. The Møller matrix is used as generating function for all Fock-space amplitudes of the system. In this way are exhibited (*a*) the Green's function renormalization constant (Z_2 of Dyson), (*b*) the mesic proper field of the source, and (*c*) that matrix which describes scattering of a single meson. The latter, distinct from the classical one-particle scattering matrix, is obtained by solving a singular integral equation and shown to provide the same meson scattering amplitude. It is seen that only the one-meson amplitude of the one-meson state is singular on the energy shell, in agreement with the simple one-channel form of the *S*-matrix. An alternative treatment of the theory from the point of view of the equations of motion of the source is presented in an appendix. A.

530.145

6760. Nonrelativistic interaction between two nucleons. D. FELDMAN. *Phys. Rev.*, **98**, *No.* 5, 1456–70 (*June* 1, 1955).

The problem of the derivation of a two-nucleon Schrödinger equation from quantum field theory has been investigated, where only those mesons which are exchanged between the nucleons are taken into account. One expects that the two-particle Schrödinger picture will be useful if the energy (less rest energy) is small ($\lesssim \mu^2/M$), and if the important matrix elements are those which couple states of small momenta ($\lesssim \mu$). The procedure which has been followed has been to go over to Fock space in the manner of Tamm and Dancoff, and then to decouple the two-particle Tamm–Dancoff amplitude from all the others by a series of canonical transformations (the over-all coupling is assumed weak). Unlike the methods developed by Lévy–Klein and Bethe–Salpeter, the characteristic difficulties such as energy-dependent and non-Hermitian potentials are avoided. By way of application, the formalism is used to analyse the nonrelativistic nuclear forces for the neutral scalar and charge-symmetric pseudoscalar theories (with both pseudoscalar and pseudovector coupling). In this approximation, it is shown that there is agreement with the results of Lévy–Klein. In the course of the calculations, it is made evident that the "nonadiabatic velocity-dependent" corrections of Lévy–Klein appear even when the nucleons are taken to be fixed sources. Within the context of the method of canonical transformations, there is no justification for dropping these corrections as has been suggested by Brueckner and Watson. Finally, there is some evidence that the Tamm–Dancoff approximation is not an improvement over weak-coupling perturbation theory when applied to the nuclear-force problem, at least when the coupling constant is small. A.

530.145

6761. Effect of renormalization on meson–nucleon *S*-scattering. M. M. LÉVY. *Phys. Rev.*, **98**, *No.* 5, 1470–8 (*June* 1, 1955).

Renormalization prescriptions are given for the covariant integral equations of meson–nucleon scattering, taking into account the difficulties of overlapping divergences. The covariant wave equations, corresponding to the iteration of second-order irreducible processes, are solved approximately and renormalized in closed form (in the case of the pseudoscalar theory with pseudoscalar coupling). The *S*-phase shifts corresponding to the states of isotopic spin 1/2 and 3/2 are computed, and their variation with energy is compared with experiment. The only parameter which can be adjusted is the meson–nucleon coupling constant *G*. It is found that a good agreement with experiment is obtained when $G^2/4\pi = 7{\cdot}5$. The possibility of this agreement being purely coincidental cannot be ruled out, but other interpretations of this result are discussed. A.

530.145

6762. Many-body problem with strong forces. R. JASTROW. *Phys. Rev.*, **98**, *No.* 5, 1479–84 (*June* 1, 1955).

A trial solution constructed from two-particle functions is applied to the problem of the *N*-particle system with strong interactions. In a variational treatment based on this wave-function the expectation values, which cannot be factored into single-particle integrals, are evaluated by a cluster development in powers of the particle density. The procedure is illustrated by a calculation of the pair distribution function and zero-point energy of the hard sphere gas, for Bose and Fermi statistics. A.

530.145

6763. New method for the solution of the deuteron problem, and its application to a regular potential. F. CAP AND W. GRÖBNER. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1211–22 (*June*, 1955).

First, success and failure of the usual linear charged pseudoscalar meson theory of nuclear forces are discussed and reasons given for non-linear terms, yielding finite potential. Second, a new method of solution of the deuteron problem is given and applied to a regular pseudoscalar potential. It is shown that the discussed non-linear pseudoscalar theory yields far better results for the deuteron than the linear theory. A.

530.145 : 530.162

6764. Statistical model for high-energy events. J. V. LEPORE AND M. NEUMAN. *Phys. Rev.*, **98**, *No.* 5, 1484–7 (*June* 1, 1955).

The relative probabilities for alternate processes initiated by a nucleon–nucleon collision depend on the dynamics involved and on the volume in phase

space accessible to each final state. The assignment of relative *a priori* probabilities to the final states proportional to their extension in phase must be consistent with the translational, rotational and Lorentz-invariant properties of the colliding system. The latter in particular implies a conservation law for the centre of energy. Its effect is not only to lower the power of the configurational volume by one dimension but also to severely reduce the contributions from high momenta to the phase space integrals. The limitations on accessibility arising from the controllable constants of motion are not sufficient to insure well defined probabilities. Some additional restriction on the configurational part of the phase space must be imposed. A cut-off factor for each particle is accordingly introduced. The configurational volume accessible to the particle thus decreases with increasing energy, a picture not inconsistent with the uncertainty principle. A.

530.145

6765. On the hydrodynamical representation of non-relativistic spinor equation. T. TAKABAYASI. Letter in *Progr. theor. Phys.*, **12**, *No.* 6, 810–12 (*Dec.*, 1954).

The problem of spin is treated by introducing a spin density; equations of motion connecting it with the ordinary density and velocity functions are obtained. G. E. BROWN

530.145

6766. Mathematical foundations of quantum mechanics. J. VON NEUMANN. [Translated by R. T. BEYER.] *London: Oxford University Press* (1955) 458 *pp.* [*Investigations in Physics No.* 2. *Princeton University Press.*]

"The first attempts at a systematic mathematical-physical approach to quantum theory were made in 1925, and the resulting transformation theory brought much closer to hand the long-sought universal mechanical concept. The present work, first published in 1932 and now translated into English for the first time, provides a comprehensive treatment of the mathematical bases of quantum theory."

530.145

6767. Applications of a method of approximation to the second order term in perturbation theory. P. KESSLER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1314–17 (*March* 21, 1955) In French.

The author's method [Abstr. 5225 (1955)] is applied to three examples for a two-electron atom.

P. T. MATTHEWS

530.145

6768. On ergodic theory in quantum mechanics. R. JANCEL. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1693–5 (*April* 25, 1955) In French.

An ergodic theorem in quantum mechanics was previously obtained by several authors [von Neumann (1929), Pauli and Fierz (1937), Ludwig, Abstr. 1005 (1954)]. It is now proved under less restrictive conditions on the system to which it applies.

L. S. GODDARD

530.145

6769. On the fundamental hypothesis of statistical quantum mechanics. R. JANCEL. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1864–6 (*May* 9, 1955) In French.

A continuation of previous work (preceding abstract). It is now shown that an ergodic theorem given earlier is not necessary in statistical quantum mechanics. Conditions are studied under which physical magnitudes may be represented by phase means [moyennes en phase]. L. S. GODDARD

530.145

6770. Orthogonality of the Furry–Sommerfeld–Maue wave functions and their use in perturbation theory. R. T. SHARP AND J. D. JACKSON. Letter in *Phys. Rev.*, **98**, *No.* 4, 1128 (*May* 15, 1955).

It is claimed that these wave-functions, previously discussed by Horton and Phibbs [Abstr. 8069 (1954)], can be considered orthogonal and no modification of perturbation theory is needed on account of their use. G. FIELD

530.145

6771. Generalized beta invariants. R. J. FINKELSTEIN. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1104–12 (*June*, 1955).

A wave-equation covariant under conformal transformations is proposed. Generalized β-invariants are constructed from the eight-rowed wave-functions which satisfy this equation, and some of their formal properties are derived. A.

530.145

6772. Direct evaluation of fractional parentage coefficients using Young operators: normalization of four-particle wave functions. M. J. ENGLEFIELD. *Phys. Rev.*, **98**, *No.* 5, 1213–15 (*June* 1, 1955).

In a recent paper by Jahn, four-particle wave-functions of specified symmetry were generated by using Young operators. When three of the angular momenta of the individual particles were the same, the functions were not normalized, an undetermined factor $N_{\alpha\beta}$ being introduced. Explicit expressions for this factor, in terms of the Hope χ function, are given below. A.

530.145

6773. Generation of Coulomb wave functions by means of recurrence relations. I. A. STEGUN AND M. ABRAMOWITZ. *Phys. Rev.*, **98**, *No.* 6, 1851–2 (*June* 15, 1955).

A discussion of the computation of Coulomb wave-functions from their recurrence relations is given. Specifically, it is demonstrated that the regular solution F_L and the irregular solution G_L may be obtained recursively based on the knowledge of the functions for $L = 0$. A.

530.145 : 539.153.4

6774. Configuration interaction in orbital theories. R. K. NESBET. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 312–21 (*June* 21, 1955).

A systematic method is developed for estimating or calculating corrections for configuration interaction in atomic, molecular and nuclear wave-function calculations. Solutions of the Hartree–Fock equations for a single Slater determinant or approximate Hartree–Fock solutions obtained by Roothaan's iterative procedure have special properties which are used to simplify the matrix of the many-particle Hamiltonian. A restricted self-consistent field method is proposed for treating states of low symmetry. This method

avoids the off-diagonal Lagrange multipliers encountered in previous methods and is adapted to configuration interaction calculations. A.

530.162

6775. Statistical weights in many-particle systems. Y. YEIVIN AND A. DE SHALIT. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1146–51 (*June*, 1955).

A general formula for the statistical weights $G_{\nu n}(S)$ of the states, with total spin S, of a system of ν spin $\frac{1}{2}$ and n spin 1 particles is derived by combinatorial methods. A.

530.162

6776. The binary distribution function for a system of charged interacting particles. I. I. R. YUKHNOVSKIĬ. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 690–8 (1954) In Russian.

A procedure is given for solving Bogolyubov's equations for a system of interacting particles of zero resultant charge [N. N. Bogolyubov, *Problems of dynamical theory in statistical physics*, GTTI, 1946]. The interaction is described by a phenomenological potential $\Phi(r) = (1 - e^{-\alpha r})/r$. General expressions are derived for the 1st, 2nd, . . . kth approximation to the binary distribution function, with the concentration as the expansion parameter. "Correlation graphs" are introduced to illustrate the high-order correlations which arise in rapidly increasing numbers with increasing k. Numerical applications are not attempted. W. J. SWIATECKI

530.162 : 532.527 : 534.2

6777. On the statistical mechanics of an adiabatically compressible fluid. R. H. KRAICHNAN. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 438–42 (*May*, 1955).

The extension of classical statistical mechanical methods to non-Hamiltonian systems is discussed. The statistical equilibrium of a confined adiabatically compressible fluid is examined on the basis of a generalized phase space representation, and it is found that there exists a tendency towards equipartition of energy between compressive and vorticity modes which is modified by the viscous dissipation forces. The application of the method to determining non-equilibrium energy transfers between acoustic modes and vorticity modes is discussed. A.

GENERAL MECHANICS
MECHANICS OF SOLIDS 531

531.258

6778. The disturbance of stress in an infinite plate by a lemniscate-shaped hole. W. SNOWDON. *Brit. J. appl. Phys.*, **6**, *No.* 6, 220–3 (*June*, 1955).

Curvilinear co-ordinates are used to determine the functions of a complex variable, from which may be deduced the components of stress and displacement for an infinite plate perforated by a double hole, the boundary of which is the lemniscate of Bernoulli. Four cases are considered; in the first, the plate is assumed to be under simple tension in any direction; in the second, the plate is assumed to be in a state of uniform all-round tension ; in the third, it is supposed to be in a state of pure shear having any orientation to the lemniscate; and in the fourth, the hole is assumed to be an area of compression in an otherwise undisturbed plate. In each case, expressions are obtained for the stress at the edge of the hole, and numerical values of this stress are tabulated and displayed graphically. A.

MECHANICAL MEASUREMENTS 531.7

531.717 : 534.242

6779. Thickness measurement by ultrasonic resonance. E. G. COOK AND H. E. VANVALKENBURG. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 564–70 (*May*, 1955).

A mathematical analysis is made of the acoustic system of resonance-type instruments used for thickness measurements from one side only. The approach is general and can be used to evaluate any combinations of test sample, couplant and driving crystal provided their acoustic properties are known. Correlation between the theory and experimental data is discussed. The results of the analysis have been used to compute thickness calibration screens and tolerances on components for a specified testing problem. A.

531.752

6780. [Self-] recording magnetoelectrical balances. M. A. GUREVICH AND K. P. MALYUS-MALITSKIĬ. *Zh. tekh. Fiz.*, **24**, *No.* 9, 1724–8 (1954) In Russian.

In a laboratory the course of some change, e.g. chemical reaction, is often followed by taking a continuous record of a variation in weight. For such a purpose the authors have modified a voltmeter to serve as a balance. The hair-spring controls were removed, the core bored to take a spindle which was firmly attached to the frame of the coil. At right angles to the spindle is fixed a light rod serving as balance arm, carrying a specimen hanging on a fine wire at one end and a counterpoise at the other. The spindle also has attached to it a small mirror. A beam of light is directed at the mirror and, with change of weight, the reflected light passes over the cathodes of two photocells connected in series. From the join of the two cells a lead is taken to the grid of a triode valve. The p.d. across the cathode load of the latter is registered on the recording apparatus. In series with the cathode load resistor is a milliammeter and the coil of the (voltmeter) balance, the current direction through the latter being chosen so as to provide a couple opposing the effect of change of weight hung on. Except in so far as friction on the spindle modifies the law there is a linear relation between change of weight and change of restoring current. The authors claim to measure a relative change of weight of 3×10^{-6}. A modification of the equipment makes possible differential recording. In this case the valve cathode circuit does not include the conventional recorder or the (voltmeter) balance coil, but the loop of a Duddell type oscillograph instead. Wherever the valve current is large enough to cause a deflection of the oscillograph spot right across the recording strip the p.d. across a resistor in the cathode circuit connected to the grids of two thyratrons causes one or other of these to fire and actuate a

relay controlling a decade rheostat in a circuit containing the balance (voltmeter) coil. The oscillograph spot is then brought back to the other side of the recording strip. A record is shown for the drying out of a 2 g pellet of unbaked porcelain. The total loss of 300 mg is shown, against this, as a saw-tooth trace, each traverse of the strip corresponding to a change of 0·4 mg. C. R. S. MANDERS

531.752 : 541.183

An electromagnetic sorption balance. *See Abstr.* 7480

MECHANICS OF FLUIDS 532

532.13 : 532.59

6781. Radiation pressure of viscosity waves. R. LUCAS AND J. GUELFI. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 18, 1758–9 (*May* 2, 1955) In French.

A plane surface executing sliding harmonic motion in contact with a viscous fluid produces transverse waves of which the characteristics and an expression for the radiation pressure they exert are given; apparatus for demonstrating the existence of this radiation pressure is described. J. S. G. THOMAS

532.13 : 536.2

6782. Heat conductivity–viscosity relationship for liquids. S. R. MOHANTY. Letter in *J. sci. industr. Res.*, **14B,** *No.* 1, 35–6 (*Jan.*, 1955).

Shows that for a large number of liquids $MK/\eta R$ (M molecular weight, K thermal conductivity, η viscosity) ranges from 0·5 to 5·8, low values being characteristic of associated liquids whilst long chain molecules generally have high values. See also Abstr. 8543 (1951). F. E. HOARE

532.137

6783. Precision rotation viscometer with electrostatic restoring torque for the centipoise range. H. EISENBERG AND E. H. FREI. *J. Polymer Sci.*, **14,** 417–26 (1954).

This concentric cylinder viscometer with conical ends is designed for the study of dilute high-polymer solutions. SCIENTIFIC INSTRUMENT RESEARCH ASSOC.

532.137

6784. The bar viscometer. D. TOLLENAAR AND M. C. BISSCHOP. *J. Colloid Sci.*, **10,** *No.* 2, 151–5 (*April*, 1955).

An instrument in which an accurately machined and polished bar falls through a ring, with the material under test in the annular gap, is suitable for viscosity measurements at shear stresses of 10^4 to 10^6 dyne/cm^2. The temperature rise can be arranged to be much smaller than in a rotating cylinder viscometer at the same shear stress by using narrower gaps (down to 0·030 mm). J. G. OLDROYD

532.137

6785. An improved rotational surface viscometer. E. SANDERS, K. DURHAM AND M. CAMP. *Research* Correspondence, **8,** *No.* 4, S 18–S 20 (*April*, 1955).

The instrument described and shown diagrammatically is a two-dimensional equivalent of the Couette viscometer and consists of a shallow stainless steel pan rotated at an adjustable constant speed about a Polythene bob in the form of an inverted shallow cup. A continuously variable-speed drive mechanism and an air thermostat are provided. An experimental curve is given of bob deflection against rotational speed for a 0·05% sodium dodecyl sulphate solution containing 0·005% dodecanol, using a 36 s.w.g. torsion wire of torsional constant 154 dyne. cm/rad. S. WEINTROUB

532.137

6786. A cone-and-plate viscometer. H. MARKOVITZ, L. J. ELYASH, F. J. PADDEN, JR AND T. W. DEWITT. *J. Colloid. Sci.*, **10,** *No.* 2, 165–73 (*April*, 1955).

A weight-driven cone-and-plate viscometer is described. It has a simpler construction and can be used over a wider range than some other instruments of this type. Liquids with viscosities from 1 to 50 000 poises have been investigated, and rates of shear from 0·000 2 to 9 000 sec^{-1} have been achieved with this instrument. With one filling of the viscometer, a 1 000- to 30 000-fold range of rates of shear can usually be covered. With concentrated polymer solutions, it is practically always possible to determine the zero shear viscosity. A.

532.14 : 533.12

6787. Exact method for the calculations of coexistent densities from van der Waals' type equations. S. W. BENSON AND C. S. COPELAND. Letter in *J. chem. Phys.*, **23,** *No.* 5, 974–5 (*May*, 1955).

An algebraic equation between simple functions of coexistent densities is obtained. The mathematical deductions are exact but the result depends on the validity of particular equations of state. Results are applied to the neighbourhood of the critical point. It is found that the sum of coexistent densities, but not the sum of coexistent volumes, is a linear function of the temperature. Regarding the differences of coexistent densities, the validity of accepted relations is questioned. The evaluation of the formulae is carried out by numerical computation. No algebraical proof is offered for the conclusions. R. EISENSCHITZ

532.51

6788. The stability of a combined current and vortex sheet in a perfectly conducting fluid. D. H. MICHAEL. Note in *Proc. Cambridge Phil. Soc.*, **51,** *Pt* 3, 528–32 (*July*, 1955).

It is shown that a plane current sheet in a perfectly-conducting inviscid fluid at rest is stable to small 2-dimensional disturbances at the surface of discontinuity; and that, when in a fluid, a vortex sheet coincides with a current sheet, the stability of the former is enhanced by the latter's presence. D. R. BARBER

532.517.4

6789. Statistical theory of turbulence. I. Hypothesis of vortex chaos motion. Y. SHIGEMITSU. *J. Phys. Soc. Japan*, **10,** *No.* 6, 472–82 (*June*, 1955).

First, some experimental observations are made on transition to turbulent flow, in view of which it is defined as an irregular motion of many large and small vortices. Next, kinematical expressions of intensity and scale of turbulence are given in the form of area integrals of the product of the mean velocities $\bar{V}_*^2$ and $\bar{V}_*'^2$ in many vortices and a probability density function P, where the latter means physically the

character of an irregularity in the relative arrangement of many vortices. With these expressions and the Reynolds equations introduced, fundamental equations of motion of turbulence are set up. A statistical principle for determining the functional form of P is described, based on the physical meaning of the ergodic hypothesis in statistical mechanics. Finally, $\bar{V}_*^2$ and $\bar{V}_*'^2$ are discussed hydrodynamically with reference to the known solution of the Navier–Stokes equations for a certain vortex motion. A.

532.582.7

6790. Rotations, orientations and collisions of suspended particles in velocity gradients. R. St. J. Manley, A. P. Arlov and S. G. Mason. Letter in *Nature* [*London*] **175,** 682–3 (*April* 16, 1955).

In a liquid in laminar flow an immersed rod-shaped particle is kept in steady, strictly periodic rotational movement by the viscous forces. It was not known to what extent this is interfered with by the inertia of the liquid. By observing the movement of single particles the authors are able to follow a large number of successive periods without finding any interference. There appears, however, to be interference in suspensions of many particles due to the interaction between the suspended bodies; this is shown by observing the instantaneous angular distribution of the rods. Observations on suspensions of spherical particles show that, in general, the particles do not come into contact; "collisions" between the particles appear to be due to hydrodynamical interaction. Further experiments are made with immersed air bubbles, studying the coalescence of two bubbles into one.

R. EISENSCHITZ

532.72

6791. Hydrodynamic model representing diffusion processes with diffusion coefficients depending upon concentration. W. Knappe. Note in *Z. angew. Math. Phys.*, **6,** *No.* 2, 140–2 (1955) In German.

Models for assisting in deriving solutions of Fick's non-stationary diffusion differential equations in the form $\partial c/\partial t = -\operatorname{div}\sigma = \operatorname{div}\sigma(D \text{ grade})$ are suggested. When the diffusion coefficient has a constant value, the model comprises a number of vertical cylinders containing liquid and delivering at their bases into a horizontal tube; when the value of the diffusion coefficient depends upon the concentration, the cylinders are replaced by inverted conical vessels delivering into the horizontal conduit. J. S. G. THOMAS

532.739.2

6792. The relative solubility of hydrogen and deuterium in liquids at low temperatures. S. K. Lachowicz. *Research* Correspondence, **8,** *No.* 6, S 27–S 28 (*June*, 1955).

By referring to results of measurements, by plausible extrapolations and by using a semi-empirical formula given by Hildebrand, it is concluded that deuterium has a higher solubility than hydrogen in liquefied nitrogen, methane and similar liquids.

R. EISENSCHITZ

532.74

6793. On association in binary liquid mixtures. L. Rothhardt. *Z. phys. Chem.* [*Leipzig*] **204,** *No.* 3–4, 215–22 (*May*, 1955) In German.

An expression is derived for the compressibility of binary liquids. It is first shown how a simple additive law is sufficient for a mixture without association and then how an additional term is introduced to account for association. It is assumed that dynamic equilibrium, which obeys the law of mass action, exists between the unassociated molecules and the complexes.

T. C. TOYE

532.77 : 541.13

6794. Electrons in solutions. J. Jortner and G. Stein. Letter in *Nature* [*London*] **175,** 893–4 (*May* 21, 1955).

The possibility of a stable bound state of electrons with water, such as H_2O^-aq., ranging in energy between 25 and 70 kcal per mole is discussed, and an experiment described in which freshly-distilled potassium, on reacting with water, gives an absorption spectrum with a sharp and prominent maximum at a little above 900 mμ. W. GOOD

CAPILLARITY 532.6

532.612.4

6795. Liquid surface tension measurements by analysis of solid-state curvatures; the surface tension of liquid germanium. R. C. Sangster and J. N. Carman, Jr. *J. chem. Phys.*, **23,** *No.* 6, 1142–5 (*June*, 1955).

A procedure based upon zone-melting techniques has been developed for determining liquid-gas surface tension coefficients for liquids at their melting points by analysis of the surface curvatures of solid specimens. The method can give standard deviations of the mean of the order of $\pm 1\%$. It has been calibrated with lead and cadmium to be valid to within at least ± 5–10%. The most important factors limiting its range of applicability are crystallographic forces which produce facets on the solid and the difficulty of producing and maintaining a clean liquid-gas surface. The surface tension of liquid germanium at its melting point, 934·5°c, in contact with helium or nitrogen has been found to be 632 ± 5 dyne/cm, in good agreement with a previously reported value. A.

532.62

6796. How does a soap bubble burst? M. Kornfel'd. *Zh. tekh. Fiz.*, **24,** *No.* 8, 1520 (1954) In Russian.

A sequence of 6 high-speed photographs shows the skin of the bubble contracting to a small disk, with filaments of droplets extending from the edge.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

6797. The cell theory of liquids. J. A. Barker. *Proc. Roy. Soc. A,* **230,** *No.* 1182, 390–8 (*June* 21, 1955).

The cell concept is used as basis for a formally exact theory of liquids. Methods for evaluating the integrals required are indicated, and sufficient

numerical results are obtained to discuss the importance of (i) multiple occupation of cells, (ii) correlation or coupling of motion of molecules in different cells, (iii) "smearing" of the potential due to neighbours. Current cell theories are examined in the light of the results. A.

532.7 : 532.528 : 534.321.9

Observations of phenomena occurring in liquids irradiated by ultrasonics, in the presence of different gases at variable pressures. *See Abstr.* 6843

532.73 : 534.23

Absorption of underwater sound by substances in process of solution. *See Abstr.* 6835

532.73–1 : 535.343

The study of solutions of gases by infrared spectrography. *See Abstr.* 6921

532.77 : 536.75

6798. On the entropy of mixing of liquid solutions. A. ENGLERT-CHWOLES. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1168–9 (*June*, 1955).

The heat of mixing of the system CCl_4–neopentane in which the molecules have the same size has been measured at 0°C. The molar value is 75 ± 5 cal for a mole fraction of 0·5, leading to an excess entropy of (-1 ± 8) cal.mole^{-1} at the same concentration. This and other excess properties of 8 binary solutions are tabulated and the results found to be in general agreement with the cell theory. R. O. DAVIES

MECHANICS OF GASES 533

533.15

6799. Interdiffusion in the gaseous systems: BF_3–CCl_4 and BCl_3–CCl_4. C. J. G. RAW. Letter in *J. chem. Phys.*, **23**, *No.* 5, 973 (*May*, 1955).

Diffusion is observed by means of a steady-state method: the meniscus of liquid carbon tetrachloride in a capillary which, at its upper end, is in contact with a flowing boron compound, falls at the rate at which vapour is removed by diffusion. Diffusion coefficients at 30°C are found to be: 0·045 and 0·034 cm^2.sec^{-1} for boron trifluoride and boron trichloride respectively. Results are correlated with the viscosities of the three vapours by the way of a potential energy of molecular interaction. Agreement of theory and experiment is reasonably good. R. EISENSCHITZ

533.15

6800. The separation tube. XIV. The swing separator. Thermal-diffusion factors in the CO_2/H_2 system. K. CLUSIUS AND M. HUBER. *Z. Naturforsch.*, **10a**, *No.* 3, 230–8 (1955) In German.

For Pt XIII, see Abstr. 2092 (1955). A new apparatus is described, with which the thermal-diffusion factor α may be determined for such small temperature differences, that one obtains "true" rather than "average" values for α. It consists of a number of vertical tubes, the upper ends of which are heated and the lower ends cooled. Capillary tubes connect the vertical tubes in series, and a small pump drives the gas to and fro in the system. The separation factor "q" for a single tube rises to q^z for z tubes. This method is suitable for the determination of α at any temperature, pressure and proportion of mixture, and has been used for the CO_2/H_2 system. The first approximation by Chapman based on the 6·12 molecular model of Lennard-Jones, does not show good agreement with the observed values of α. However, the approximation due to Kihara shows good agreement with experiment, particularly for the dependence of α on temperature and mixture proportions, and marks a noteworthy step in the theoretical treatment of thermal diffusion. H. C. COLE

533.15 : 534.321.9

6801. Measurements of thermal diffusion in H_2–He mixtures by using ultrasonics. A. VAN ITTERBEEK AND J. NIHOUL. *Acustica*, **5**, *No.* 2, 142–5 (1955).

An ultrasonic interferometer has been used to measure the change of the concentration produced by thermal diffusion in H_2–He mixtures. With this method the separation degree has been measured as a function of the concentration and the temperature. From these measurements the thermal diffusion factor α was found to be 0·149. The change of the concentration as a function of time was measured in H_2–N_2 mixtures by means of the velocity. Good agreement with Clark Jones and Furry's theory (1946) was obtained. A.

533.5

6802. The physical processes occurring in diffusion and vapour-jet pumps. I. Properties of the vapour jet stability of the forevacuum. H.-G. NÖLLER. *Z. angew. Phys.*, **7**, *No.* 5, 218–25 (1955) In German.

Historical introduction, followed by a discussion of the flow properties of the vapour jet. An experimental approach in which the mercury vapour is rendered visible by gas discharge and a theoretical method are given. The processes occurring in the pump when air is admitted at the forevacuum side are explained. G. WITTENBERG

533.5

6803. The physical processes occurring in diffusion and vapour-jet pumps. II. Mixing of air and vapour, and the pumping speed. H.-G. NÖLLER. *Z. angew. Phys.*, **7**, *No.* 5, 225–9 (1955) In German.

Derivation of a general equation for pumping speed and capacity for vapour-jet, diffusion and booster pumps from considerations of the mixing phenomena of air and the vapour jet. Laminar and turbulent flow are discussed. G. WITTENBERG

533.5

6804. The physical processes occurring in diffusion and vapour-jet pumps. III. Comparison of observed and theoretically determined flow patterns. H. KUTSCHER. *Z. angew. Phys.*, **7**, *No.* 5, 229–34 (1955) In German.

Calculations and theoretical representations are shown to agree closely with observed flow patterns, which leads to the conclusion that the theoretical methods used and the assumptions made are justified. G. WITTENBERG

533.5

6805. The physical processes occurring in diffusion and vapour-jet pumps. IV. A method for measuring the pressure in supersonic vapour flow at low pressures, the results obtained and a comparison with the flow patterns. H. KUTSCHER. *Z. angew. Phys.*, **7**, *No.* 5, 234–40 (1955) In German.

A special probe enables pressures and speeds to be determined at the axis of an axially symmetrical oil vapour jet at supersonic speed. These results afford confirmation of the calculated and observed flow patterns. G. WITTENBERG

533.5

6806. Utilization of thermistors as vacuum gauges. Y. LORTIE. *J. Phys. Radium*, **16**, *No.* 4, 317–20 (*April*, 1955) In French.

A study of the use of thermistors in Pirani-type gauges in the pressure range 1 to 10^{-3} mm of Hg. Uses a Wheatstone bridge and keeps the glass envelope containing the thermistor at constant temperature. L. G. CARPENTER

533.6.011 : 538.56

6807. A system of spectral equations for magneto gas-dynamic isotropic turbulence. S. A. KAPLAN. *Dokl. Akad. Nauk SSSR*, **94**, *No.* 1, 33–6 (1954) *In Russian.*

Spectral theory of gaseous magnetic isotropic turbulence. S. A. KAPLAN. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 699–707 (1954) In Russian.

Spectral distribution follows a 5/3 law and is little dependent on the scale of mixing, the velocity of sound and the dissipation of energy as shock waves. The extension to the non-steady state is discussed. J. M. HOUGH

533.6.011.3

6808. Application of the thin-wing-expansion method to the flow of a compressible fluid past a symmetrical circular arc aerofoil. S. ASAKA. *J. Phys. Soc. Japan*, **10**, *No.* 6, 482–92 (*June*, 1955).

Imai's thin-wing-expansion method is presented in somewhat modified and extended form. Then the method is applied to the flow of a compressible fluid past a symmetrical circular arc aerofoil. Analytical expressions for the velocity potential and the velocity distribution over its surface are obtained. For the profile of thickness ratio $t = 0{\cdot}1$, numerical computations have been carried out at $M = 0{\cdot}7$ and $0{\cdot}8$. The present method has been proved very useful, because its procedures are simple and clear, and because its convergency and accuracy are very good up to quite high Mach numbers. Comparisons with theoretical results for related profiles as well as experimental data have been made. A.

533.6.011.32 : 532.525

6809. The structure of a jet of air moving at high velocity. M. MERLE. *C.R. Acad. Sci.* [*Paris*] **240**, 1972–3 (*May* 16, 1955) In French.

Particulars are given of the stationary periodic structure of a jet of air emerging from an orifice at the end of a convergent tube, when the supply-pressure exceeds a certain critical value. The structure of the jet, revealed by shadow-photography, depends upon the time of exposure used. Turbulence and deformation of the cellular structure of the jet is shown by an instantaneous exposure, of duration 1×10^{-6} sec; this turbulence disappears and is replaced by a series of sharply-defined cells, becoming progressively smaller, when an exposure of 5 sec is used. Three definite regions in the jet, possessing definite characteristic structures are established as the pressure at the orifice is changed through the values $<3{\cdot}1$, $3{\cdot}1$–$4{\cdot}9$ and $>4{\cdot}9$ kg/cm^2. A mathematical relation is established between the wavelengths characterizing the jets, the diameter of the orifice and the ratio of the actual to the critical pressure. J. S. G. THOMAS

533.6.011.6 : 536.244

6810. Influence of the angle of attack of a gas flow on the heat transfer of a circular cylinder. F. P. KAZAKEVICH. *Zh. tekh. Fiz.*, **24**, *No.* 7, 1341–9 (1954) In Russian.

MOLECULAR THEORY OF GASES 533.7

533.7

6811. Symmetry effects in gas kinetics. I. The helium isotopes. O. HALPERN AND R. A. BUCKINGHAM. *Phys. Rev.*, **98**, *No.* 6, 1626–31 (*June* 15, 1955).

Continues earlier investigations, studying the influence of the process of symmetrization of the wave-functions of the colliding atoms upon various gas-kinetic cross-sections. Through the choice of a suitable interaction potential it thus becomes possible to derive the temperature dependence of the viscosities of the two He isotopes near absolute zero; it is also possible to show that the differences between these two quantities is largely caused by the fact that the nuclei of He^3 and He^4 follow different statistics. The agreement between theory and experiment is not quite as satisfactory in the case of the viscosity of mixtures of the two isotopes. Finally, curves are presented showing the effect of symmetrization on various possible scattering experiments. A.

533.73

6812. Free energy functions for gaseous atoms from hydrogen ($Z = 1$) to niobium ($Z = 41$). T. J. KATZ AND J. L. MARGRAVE. Letter in *J. chem. Phys.*, **23**, *No.* 5, 983 (*May*, 1955).

These are given in a table, for four different temperatures, and are calculated with an electronic calculator. Nuclear spin contributions have not been considered. C. TURNER

533.75

6813. Pressure-volume isotherms of He^3 between 1·5 and 3·8°K. W. E. KELLER. *Phys. Rev.*, **98**, *No.* 6, 1571–5 (*June* 15, 1955).

PV isotherms of He^3 gas have been measured at $3{\cdot}786$, $2{\cdot}991$, $2{\cdot}161$, $1{\cdot}818$ and $1{\cdot}516$°K. Values of the second virial coefficient, *B*, derived from the data, are, respectively, $-65{\cdot}37$, $-86{\cdot}25$, $-117{\cdot}9$, $-142{\cdot}3$ and $-168{\cdot}0$ cm^3/mole. For only the isotherms of $3{\cdot}786$ and $2{\cdot}991$°K was the third virial coefficient found to be significant. These values are 1132 and 1718 (cm^3)^2/mole^2, respectively. The measured *B*'s are shown to be in satisfactory agreement with those

calculated using a modified Slater–Kirkwood type potential, with constants chosen to give a good fit to the measured He^4 B's below 4°K. A.

VIBRATIONS . ACOUSTICS 534

534.01 : 621–52

6814. Conditions for aperiodicity in linear systems. A. T. FULLER. *Brit. J. appl. Phys.*, **6**, *No.* 6, 195–8 (*June*, 1955).

The necessary and sufficient conditions which a linear system must satisfy to be completely aperiodic are derived. They may be expressed in terms of either the roots or the coefficients of the characteristic equation. In the latter case, the conditions take the form of a number of simple determinantal inequalities which are closely analogous to the Routh–Hurwitz stability criteria. A.

534.13

6815. Gaseous oscillations within a perturbed spherical resonator. I. D. CAMPBELL. *Acustica*, **5**, *No.* 2, 145–8 (1955).

A perturbation method is used to investigate theoretically the modes of oscillation of a gas within an almost spherical resonator. It is shown that the pressure distribution may be represented by the pure mode together with small contributions from other "forced" modes. Under some circumstances the resonant frequencies are unperturbed, to the order of approximation adopted. A.

534.141.4

6816. On the production of sound by jets. N. THOMAS. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 446–9 (*May*, 1955).

An analysis of sound production by vortices in air jets is given. Specifically, the flow of air through sharp-edged orifices is considered, and it is shown how the results of Anderson on the excitation of jet-tones under these conditions may be explained. The analysis also covers excitation of resonant cavities by the jet, a phenomenon giving rise to pipe-tones. A.

534.142.4 : 534.413 : 536.46

6817. On the stability of a plane flame front in oscillating flow. G. H. MARKSTEIN AND W. SQUIRE. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 416–25 (*May*, 1955).

Recent experimental studies revealed a close connection between spontaneous excitation of organ-pipe oscillations by flames propagating in tubes and flame front instability characterized by cellular structure. On the basis of these observations a dominant mechanism of vibratory flame movement is proposed, consisting of the following two steps. 1. As a consequence of acceleration instability, the oscillation of the gas column alternatingly distorts and flattens the flame front, thus creating the observed vibration-induced cell structure. 2. The distortions of the flame front cause in turn periodic changes of flame surface area and therefore of burning rate. Spontaneous oscillations are excited if the phase relation between burning rate variation and pressure oscillation is favourable. Only the first step is analysed. The linearized treatment yields stability limits in terms of dimensionless parameters representing amplitude and frequency of gas column oscillation and wavelength of flame front distortion. The properties of the flame front entering into the analysis are the ratio of densities of unburned and burned gases, the burning velocity of the plane flame front and a characteristic length that determines its stability in the absence of oscillations. Results in qualitative agreement with experimental observations are derived. A.

534.21 : 534.511.1 : 532.7

6818. Rotation processes in ultrasonic interference fields. W. SCHMITZ AND R. GROSS. *Z. angew. Phys.*, **7**, *No.* 3, 137–44 (1955) In German.

The effects of interference patterns due to ultrasonic standing waves in water are studied. Two plane waves at right angles are generated by a common 1 Mc/s oscillator and the movements of particles of aluminium bronze (100 μ size) suspended in the water are observed through a microscope. When the waves are in phase the particles cluster to points $\frac{1}{2}\lambda$ apart; when the phase difference is 90° they show rotations of frequency up to 10 c/s. An analysis of the cause of movements is given. F. T. FARMER

534.213

6819. Note on the papers: I. "Combined translational and relaxational dispersion of sound in gases," by M. Greenspan; II. "The effects of viscosity and heat conduction on the transmission of plane sound pulses," by J. R. Knudsen. S. JARVIS, JR. Letter in *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 613 (*May*, 1955).

See Abstr. 3203, 3205 (1954). For the "Becker" gas, the heat conductivity K and viscosities (μ, λ) satisfy $K = (2\mu + \lambda)C_p$; transient three-dimensional acoustic pressure disturbances are propagated according to a third-order equation derivable from the Navier–Stokes equations. A.

534.213 : 532.51 : 537.533.72

6820. Electromagnetic analogy to sound propagation in moving media. R. H. KRAICHNAN. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 527–30 (*May*, 1955).

An analogy is developed between the paths of sound rays in fluids undergoing shear flow and electron trajectories in magnetic fields. If the Mach number of the flow is small, and the characteristic eddy size large compared to the sound wavelength, the ray paths coincide with electron trajectories in a magnetic field everywhere parallel and proportional to the vorticity vector. The ratio of the magnitude of the magnetic field to the electron momentum is determined by $e\mathbf{H}/Pc_0 = \psi/c$ where $\mathbf{H}$ = magnetic field, P = electron momentum, e = electron charge, c_0, c = velocities of light and sound, ψ = vorticity. Mathematically the analogy is implied by the similarity between the eikonal equation for the sound rays and the Hamilton–Jacobi equation for the electrons. Simple illustrations of the correspondence are given. A.

534.213.4 : 534.232

6821. The thrust on a piston driven half-open tube. G. E. HUDSON. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 406–16 (*May*, 1955).

The motion of the gas in and near a tube open at one end and closed at the other by a piston driven in

nearly sinusoidal motion is investigated. Experiments disclose that when the frequency of the piston motion is near the fundamental acoustic resonance frequency of the gas column an intermittent air jet associated with a system of vortex rings is expelled from the tube's open end. This results in an appreciable average thrust on the tube, which, however, is much less than might be expected from purely acoustic considerations. A theoretical analysis has been made which takes account of the intermittent vortex and jet formation, as well as of the acoustic radiation field. The analysis leads to formulae for the average thrust and power dissipation and to a relation between the driving frequency and the amplitude of the gas motion at the open end. An empirical parameter κ which represents the fraction of energy dissipated in vortex motion appears in these formulae. It is found possible to evaluate this parameter in terms of the observed thrust at resonance. From this datum the curve of thrust *v.* driving frequency is calculated and is found to agree well with experiment. A.

534.22/.23 : 532.623

6822. Phase velocity and absorption measurements in water containing air bubbles. F. E. Fox, S. R. Curley and G. S. Larson. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 534–9 (*May*, 1955).

The phase velocity and absorption of a continuous train of sound waves in water containing air bubbles were measured as functions of frequency from 10 kc/s to 1 Mc/s. The data are in fairly good agreement with theories by Meyer and Skudrzyk and Carstensen and Foldy. For the bubbles investigated which constituted 0·02% of the volume, phase velocity varied from 500 m/sec to 2500 m/sec and peak absorption was over 30 db/cm. A.

534.22/.23 : 532.7

6823. Absorption and velocity of ultrasonic waves of finite amplitude in liquids. D. M. Towle and R. B. Lindsay. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 530–4 (*May*, 1955).

Reports the results of measurements of the attenuation and velocity of ultrasonic waves in various liquid media as a function of the intensity level at the detector of the radiation. The attenuation in distilled water and dilute solutions of acetic acid and sodium acetate is found to increase almost linearly with the acoustic excess pressure amplitude in the range from 2 to 7 atm, for frequencies of 4, 5, 7 and 9 Mc/s. The attenuation in glycerine shows a similar increase when correction is made for the unavoidable rise in temperature of the medium. The rate of increase is found to be practically independent of frequency in the range employed, thus disagreeing with the prediction of R. D. Fay's theory of the attenuation of high-amplitude plane waves. No change of velocity with source intensity has been observed. A.

534.22/.23 : 532.7

6824. Pressure dependence of sound propagation in the primary alcohols. E. H. Carnevale and T. A. Litovitz. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 547–50 (*May*, 1955).

Measurements of sound absorption and velocity were made on the ethyl, methyl, *n*-propyl and *n*-butyl alcohols up to a pressure of 2000 kg/cm^2. The results showed that both the shear and compressional viscosities of these liquids increased as the pressure increased, the pressure dependence of the compressional viscosity being the smaller of the two. Measurements of the temperature dependence of the absorption in *n*-butyl alcohol at 2000 kg/cm^2 showed that no detectable difference in the activation energies for the two viscous processes was caused by the high pressure. It was found that the two-state structural relaxation theory proposed by Hall to explain sound absorption in water is inadequate to explain the pressure dependence of sound absorption of the alcohols. A.

534.22 : 532.7

6825. On the molar sound velocity in liquids and the liquid state. H. I. Leon. Letter in *J. chem. Phys.*, **23**, *No.* 5, 983–4 (*May*, 1955).

An attempt at theoretical support for Rao's observation that the thermal coefficient of sound velocity in organic liquids is equal to three times the thermal coefficient. Numerical study of the velocity of sound expression derived from the wave equation gives the ratio of 3 at n.t.p. only, while Kittels's equation of state, viz. $PV_a = 3RT$ [V_a = (actual vol.) − (vol. of closest packing)], gives an absurd result if the empirical equations are strictly correct.

T. C. Toye

534.22 : 539.3

6826. Dispersion of ultrasonic pulse velocity in cylindrical rods. L. Y. Tu, J. N. Brennan and J. A. Sauer. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 550–6 (*May*, 1955).

The velocities of pulsed longitudinal and shear waves in cylindrical rods of aluminium alloy, brass, copper and steel were measured by using both the pulse echo and pulse transmission methods. It is found that for pulsed longitudinal waves the measured velocity not only depends upon the elastic constants of the medium but also on the ratio between the radius a of the rod and the wavelength λ. When this ratio a/λ is very small the measured velocity approximates the Young's modulus velocity $(E/\rho)^{\frac{1}{2}}$. For large values of a/λ the measured velocity approaches the bulk velocity $[(l + 2\mu)/\rho]^{\frac{1}{2}}$ where l and μ are the Lamé elastic constants. Where a/λ is in the vicinity of unity, the velocity drops and seems to approach Rayleigh surface wave velocity. This velocity dispersion effect was not observable when pulsed shear wave was used instead of longitudinal waves. A qualitative explanation for the increase of the measured pulse velocity when a/λ is large based on the equations of motion was given. A.

534.222.2

6827. Explosive shock travel times at different ambient densities. U. Ericsson. *Appl. sci. Res. A*, **5**, *No.* 4, 309–20 (1955).

An extension by dimensional analysis of the scaling law of explosives to include ambient air density and temperature is made and tested on photographic travel time measurements of luminous and non-luminous shocks from TNT spheres in rarefied air. The initial shock velocity is found to be in approximate agreement with hydrodynamic calculations. A.

534.222.2

6828. Electron beam method of determining density profiles across shock waves in gases at low densities. D. VENABLE AND D. E. KAPLAN. Letter in *J. appl. Phys.*, **26**, *No.* 5, 639–40 (*May*, 1955).

Density profiles across shock waves are observed by means of changes in the transmission of an electron beam. The shock is produced by rupturing a diaphragm which separates a high-pressure from a low-pressure chamber. The detector is a photomultiplier whose output is presented on an oscilloscope.

J. THEWLIS

534.222.2

6829. Transition through a contact region. J. G. HALL. *J. appl. Phys.*, **26**, *No.* 6, 698–701 (*June*, 1955).

The one-dimensional contact region common to shock tube flows is idealized by the simple model of initial step change in temperature and density at constant pressure. For weak transitions, neglect of pressure effects and linearization of the conservation equations gives spatially monotonic temperature and density profiles with the contact region thickening as the square root of time. Experimental results are noted from shock-tube studies of two air/air contact regions. In so far as comparison of theory and experiment is possible, the theory for weak transitions appears reasonable. A.

534.222.2

6830. Numerical solutions of spherical blast waves. H. L. BRODE. *J. appl. Phys.*, **26**, *No.* 6, 766–76 (*June*, 1955).

The strong-shock, point-source solution and spherical isothermal distributions were used as initial conditions for a numerical integration of the differential equations of gas motion in Lagrangean form. The von Neumann–Richtmyer artificial viscosity was employed to avoid shock discontinuities. The solutions were carried from 2000 atm to $<\frac{1}{10}$ atm peak overpressure. Results include overpressure, density, particle velocity and position as functions of time and space. The dynamic pressure, the positive and negative impulses of both dynamic pressure and static overpressure, positive and negative durations of pressure and velocity and shock values of all quantities are also described for various times and radial distances. Analytical approximations to the numerical results are provided. A.

534.222.2 : 551.576

6831. The propagation of explosion waves through supercooled clouds. R. SÄNGER AND F. SPRING. *Z. angew. Math. Phys.*, **6**, *No.* 1, 75–6 (1955) In German.

The concentration of ice-crystals in a supercooled cloud of water droplets was observed optically; no increase in the rate of crystallization occurred during or after the passage of a shock wave from the explosion of a small charge. A. SCHOFIELD

534.23

6832. On the theory of weakly coupled acoustic resonators in the general case. E. CHRISTIAN. *Acustica*, **5**, *No.* 2, 119–30 (1955) In German.

A perturbation calculation of the first order is made on a weakly coupled loss-free system of resonators. Beside the spread of frequency due to mistuning by coupling, that due to volume deformation is also reckoned. For given boundary conditions rigid or flexible walls are prescribed. More or less restricted conditions with respect to the mode of vibration are considered. In respect of weak coupling through the cavity and general values of the frequencies of the individual resonators, the calculation makes no special restriction. The coupling frequencies emerge as solutions of a secular determinant of which the elements are made up of energy terms. As special case a medium free of shear is considered. The functional relationship of the coupling parameter of a double resonator is derived. Finally some practical examples are given. A.

534.23 : 532.584

6833. Attenuation of ultrasound in aqueous suspensions. V. J. STAKUTIS, R. W. MORSE, M. DILL AND R. T. BEYER. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 539–47 (*May*, 1955).

Measurements of the attenuation of ultrasound in suspensions of lycopodium spores and of a quartz sand are reported. The measurements were made by means of a pulse technique in the frequency range 15–30 Mc/s and temperatures between 20° and 60°C and at various suspensoid concentrations. The results compare favourably with the theoretical calculations of Epstein. A.

534.23 : 532.73

6834. Relaxation effects in aqueous solutions of sulphur dioxide. M. KRISHNAMURTHI. *Proc. Indian Acad. Sci. A*, **41**, *No.* 4, 125–9 (*April*, 1955).

Absorption of ultrasonic energy by solutions of sulphur dioxide, ammonia and carbon dioxide in water, and in the case of the first gas in several other organic solvents, has been studied by the pulse technique. Aqueous sulphur dioxide solutions exhibit a relaxation phenomenon in the frequency range of 2 to 15 Mc/s as evidenced by the absorption ($\alpha\lambda$) showing a peak in this region when plotted against frequency. This peak occurs at higher frequencies for higher concentrations up to a limit after which the peak absorption frequency does not change with concentration. These observations, along with the fact that no such effect is observed in the case of other solvents, lead to the conclusion that the phenomenon is caused by a change in the dynamic equilibrium between H_2SO_3 molecules and H^+ and HSO_3^- ions in the presence of the sound beam. The absence of a similar effect in the case of ammonia and carbon dioxide solutions which also involve a chemical reaction is explained on the basis of the widely differing relaxation times of the three gases. A.

534.23 : 532.73

6835. Absorption of underwater sound by substances in process of solution. R. D. C. REED AND T. S. MCLEOD. Letter in *Nature* [*London*] **175**, 809–10 (*May* 7, 1955).

Very small quantities of dissolving solids (but not liquids) are observed to cause anomalous absorption. Microscopic examination demonstrated the evolution of small gas bubbles during solution and it is assumed that these bubbles are the cause of the absorption. The gas is probably included during crystallization and experiments carried out using NaCl recrystallized *in vacuo* showed a very reduced effect. T. C. TOYE

534.231

6836. The location of particles and solutions in the field of stationary ultrasonic waves. G. Keck. *Acustica*, **5**, *No.* 2, 131–4 (1955) In German.

If heavy particles are suspended in a liquid before turning on the sound field they are driven to the pressure nodes. If, however, the field is already established and the particles then added, heavy ones are driven to the antinodes, light ones to the nodes. True solutions added to the irradiated liquid move toward the nodes if they are heavier, to the nodes if lighter than the irradiated liquid. If both have the same density, the solution may move either way. A.

534.231 : 534.142

6837. On thermally induced sound fields. L. Trilling. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 425–31 (*May*, 1955).

The sound fields induced in a real gas by boundary temperature variations are examined to illustrate how the pressure, temperature and vorticity modes of motion interact. The pressure mode describes the irrotational propagation of longitudinal disturbances, the temperature mode, convective heat diffusion and the vorticity mode, the diffusion of vorticity introduced at boundaries by the no-slip condition (boundary layer). The plane sound wave due to an instantaneous wall temperature rise is a sharp pulse, travelling at sonic speed and proportional to the inverse fourth root of the acoustic Reynolds number based on distance travelled; its thickness grows as the square root of elapsed time. Along a wall, it generates a boundary layer whose friction coefficient is proportional to the inverse square root of the acoustic Reynolds number based on distance from the front. The resulting effective wall slope induces a secondary circular pressure pulse generated by the foot of the plane wave; because this source moves at sonic speed, a pressure singularity appears there, due to the contributions piled up since the beginning of the motion. A.

534.232

6838. Design of large variable resonant frequency transducers. F. J. Fry, F. Dunn and W. J. Fry. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 570–5 (*May*, 1955).

The transducer design described employs a mercury column of variable length intimately coupled to an electrically driven piezoelectric element so that a composite vibrating system is formed whose resonant frequency is capable of continuous variation. A large radiating area is realized by combining a number of such composite elements in the form of a matrix. This matrix arrangement is attached to a container which supports the mercury column. One dimension of this column is varied by means of a mechanically driven piston. The entire assembly is enclosed in a steel tank with a sound rubber window to permit its use as an underwater sound transducer. A.

534.232 : 534.862.4

6839. The mechanical input impedance of pickups. R. Kaiser. *Acustica*, **5**, 81–92 (1955) [= *Akust. Beih.*, *No.* 1 (1955)] In German.

When playing back gramophone records, commercial crystal pickups reproduce frequencies below 400 c/s only with large non-linear distortions. The high mechanical input impedance is shown to be responsible for these distortions: the lateral dynamical force rises to such high values, that the stylus loses contact with one of the groove walls. In order to determine the forces acting upon the stylus tip, the lateral and vertical mechanical input impedances are measured by one vibrometer each. Unlike the instruments previously used for these measurements, the vibrometer allows one to take measurements in the whole audio-frequency range without changing the vibrating system and with pure sinusoidal motion. Results are given for several pickups in the form of the circle diagram of the input impedance in the complex impedance plane. A.

534.232 : 621.395.625.3

6840. Survey of flux-responsive magnetic reproducing heads. O. Kornei. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 578–81 (*May*, 1955).

A magnetic reproducing head which generates a signal voltage substantially proportional to the magnitude of the intercepted magnetic flux is commonly referred to as a flux-responsive or magnetostatic head. The fundamental mode of operation, the different approaches to practical solutions, and the characteristic features of this type of head are described. The explanations are illustrated by a number of cases which have been either proposed or practically executed by various organizations and investigators. References are given, including brief abstracts of pertinent patents and other publications. A.

534.242 : 531.717

Thickness measurement by ultrasonic resonance. *See Abstr.* 6779

534.321.7.08

6841. Contribution on the standard pitch question. W. Lottermoser and H. J. von Braunmühl. *Acustica*, **5**, 92–7 (1955) [= *Akust. Beih.*, *No.* 1 (1955)] In German.

The orchestra leaders of Western Germany have been asked their opinion about the observance of the standard of musical pitch in an inquiry made by the Physikalisch-Technische Bundesanstalt (PTB) the results of which are discussed in this article. Further a method is described that allows the registration of the frequency of musical pitch with a precision of about $\pm 2{\cdot}25$ c/s. Some registrations are presented, especially those of a concert of the orchestra of the "Südwestfunk" arranged for this purpose. A.

534.321.9

6842. A contribution to the visual detection of ultrasonics by thermal methods. H. Tielsch and A. Boczer. *Z. angew. Phys.*, **7**, *No.* 5, 213–18 (1955) In German.

Several materials are available which take up a definite colour when their temperature reaches a narrow band within the range up to about 115°c. Cobalt chloride is a typical material and becomes a rose blue when its temperature reaches about 30°c. When such a material is pulverized and a thin layer of the powder is spread over a fine film of a suitable plastic material such as cellulose triacetate in methyl chloride, it becomes a useful detector of ultrasonics in that its colour will change when the energy of the

ultrasonic beam is sufficiently great to raise the temperature to the required value for the colour change to occur. Several materials having the colour-temperature property were tested and best results were obtained with mercury-silver-iodide. The films were used to study the motion of quartz and barium titanate oscillators cooled by water at 15°C and with a 5 cm spacing between the quartz and the film and 55 cm between the barium titanate oscillator and the film. The exposure time was 5 sec. A. C. WHIFFIN

534.321.9 : 532.528 : 532.7

6843. Observations of phenomena occurring in liquids irradiated by ultrasonics, in the presence of different gases at variable pressures. R. BUSNEL AND M. DEGROIS. *J. Chim. phys.*, **52**, *No.* 3, 279–93 (*March*, 1955) In French.

Measurement of the various well-known effects of ultrasonics in liquids, viz. radiation pressure, oxidation, luminescence, etc., have been made with various gas covers over the liquids at pressures up to 15 atm. Definite non-linear behaviour has been found with increasing pressure, for instance the fountain height changes little at first, then falls to a rapid minimum, after which it slowly increases; the optical density on the other hand rises to a smooth maximum value and falls away in a similar manner. Decreasing pressure shows that the effects are not completely reversible. It is thought that the effects are most probably governed by the size and number of gas bubbles per unit volume while the hysteresis observed is not, as might be expected, attributable to solubility variation. T. C. TOYE

534.321.9 : 541.14

6844. Effect of ultrasonics on solutions of KI. P. RENAUD. *J. Chim. phys.*, **52**, *No.* 4, 399–46 (*April*, 1955) In French.

The chemical effects produced are shown to depend upon a large number of conditions both ultrasonic and thermodynamic. The effects of frequency and power of the ultrasonics is discussed, the quantity of free I produced being shown to be proportional to the power. Study of the amount of work available to chemical change (i.e. product of power and time) shows among other things that the effect of cavitation is exceedingly small. The solution is regarded as a two-phase liquid-gas system and the nature of the dissolved gas is therefore discussed as well as the other usual factors of volume, concentration of KI, pH temperature and viscosity. In each case the findings of and disagreements among other workers are critically considered. The amount of free I was determined using the usual thiosulphate method. T. C. TOYE

534.321.9 : 621.374.5

6845. Ultrasonic delay lines. F. MANDYS. *Slaboproudý Obzor*, **16**, *No.* 3, 131–6 (1955) In Czech.

The system considered consists of two piezoelectric transducers (transmitter and receiver) and a delaying medium. Properties of the materials employed for the delay medium and those of the piezoelectric crystals are reviewed. A delay system consisting of two ADP, S-cut crystals, having a diameter of 15 mm and a thickness of 0·3 mm, and a 10 mm long Dural (Al–Mg5) delay medium is described; the device had a bandwidth of 200 kc/s, centred around 3·3 Mc/s, and attenuation of 50 db, its delay being 3·3 μsec. A similar system with a 208 mm long delay medium proved unsuccessful, due to a very large attenuation. R. S. SIDOROWICZ (R)

534.322.3 : 532.517.4

6846. On the spectrum of noise from turbulence. O. K. MAWARDI. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 442–6 (*May*, 1955).

An approximate method is developed for the estimation of the acoustic power frequency spectrum of the sound generated from isotropic turbulence. The method is based on a hypothetical model for the sound sources, originally produced by Lighthill, consisting of an assembly of quadrupoles extending over the region of turbulence. A.

534.39 : 537.36 : 541.135

6847. Ultrasonic waves and electrochemistry. V. The frequency characteristics of the electrokinetic and the a.c. polarized gas electrode effects. F. SAUNDERS, E. YEAGER AND F. HOVORKA. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 556–64 (*May*, 1955).

For Pt IV, see Abstr. 5750 (1953). The frequency characteristics of the acousto-electrokinetic effect and the a.c. polarized gas electrode effect have been determined with pulse-modulated ultrasonic waves in the range 200 to 1 000 kc/s as a function of solution and electrode parameters. The electrokinetic effect involves the alternating potentials produced by acoustical waves on an electrode surrounded by a porous covering in a dilute electrolyte while the a.c. polarized gas electrode effect involves the production of alternating components in the potential of a polarized electrode in an electrolytic solution with a gas such as hydrogen being liberated by a polarizing current. In the case of the electrokinetic effect, the open-circuit response relative to the pressure amplitude is inversely proportional to the frequency in very dilute solutions. The frequency dependence becomes considerably less with increasing conductance of the solution. The pressure response for the polarized hydrogen electrode also decreases with increasing frequency although the extent of the decrease is a function of current density and specific conductance. Both the response and stability of the polarized gas electrode have been greatly improved by the use of a directed flow of solution past the electrode to remove the cloud of gas bubbles in the bulk of the solution surrounding the electrode. The mechanisms proposed for these effects in earlier publications have been further substantiated by the present work. A.

534.42 : 621.395.61

6848. Electronic music synthesizer. H. F. OLSON AND H. BELAR. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 595–613 (*May*, 1955).

The music is produced from a coded record. The coded record is produced by a musician, musical engineer, or composer with a fundamental understanding of the composition of sound. The electronic music synthesizer provides means for the production of a tone with any frequency, intensity, growth, duration, decay, portamento, timbre, vibrato, and, variation. If these properties of a tone are specified, the tone can be completely described. The advantage

of the electronic music synthesizer is that it can produce new and radical tone complexes for musical satisfaction and gratification. The new system does not displace the artist and musician of today. It does not take the place of talent combined with work. The electronic music synthesizer provides the musician, musical engineer, and composer with a new musical tool with no inherent physical limitations. A.

534.44

6849. Isomorphisms between oriented linear graphs and lumped physical systems. H. M. TRENT. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 500–27 (*May*, 1955).

A unifying principle is presented whereby all finite lumped systems can be analysed by a single technique, no matter how complex the system may be. This central principle is the existence of a linear graph which is isomorphic to the dynamical properties of the elementary parts of the system and which shows how the parts are connected together. An analysis of a lumped system begins with a conceptual decomposition of the system into a number of simple parts, each of which has known dynamical properties. It is shown that if two types of scalar variables can be found such that (1) they define, with the aid of system parameters, the dynamical properties of each part of the system, (2) the first type obeys the *mesh law*, (3) the second obeys the *incidence law*, and (4) physical dimensions of appropriate products of the two types are consistent, then there exists a linear graph isomorphic with the dynamical properties of the system as described by the variables so selected. Trivial additions to the isomorphic graph yield a schematic diagram for the system. It is then shown that the algebraic properties of the schematic diagram can be used to generate in a straightforward manner a set of equations, on either the nodal or mesh basis, describing the dynamics of the system as a whole. The isomorphic graph is also the key ingredient in establishing a complete analogy. Formal procedures for establishing complete analogies are presented. A.

534.62 : 621.314.2

6850. An anechoic chamber for noise tests on large power transformers. A. W. BENOIT, R. T. HEMMES AND M. W. SCHULZ, JR. *Trans Amer. Inst. Elect. Engrs III*, **74**, 50–6 (1955) = *Pwr Apparatus Syst.*, *No.* 17 (*April*, 1955).

Describes some of the details of the design, construction, and operation of the sound laboratory recently completed by the G.E. Co. for testing transformers up to 400 tons and 500 MVA. In addition to the acoustic data, information is given on the handling arrangements, power supply, and instrumentation.

M. WATERS (R)

534.7

Physiological acoustics. Hearing. *See also under* "Medical science. Human physiology." Decimal classification 612.85

534.771 : 534.831

6851. Measurements of hearing acuity among submariners and noise levels in working compartments. J. C. WEBSTER AND L. N. SOLOMON. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 466–70 (*May*, 1955).

To study the prevalence of hearing losses among submariners, and their possible causes and consequences, the NEL warble tone hearing test was administered to 1 053 submariners. Hearing losses of less than 7 db at 500 c/s and 5 db at 1 000 c/s could not be measured due to ambient noises in the testing areas. At the other test frequencies (2 000, 4 000, and 7 000), any positive value of hearing loss could be measured. It was found that approximately 10% of all men tested had high-frequency hearing losses of 18 db or greater (at 4 000 and 7 000 c/s). A comparison of the hearing losses of enginemen to those of all others as a function of time on boat, for each frequency, showed that in general the enginemen had greater losses at all frequencies although there were minor reversals. The amount of loss was slightly less than expected from previous findings on industrial workers. A.

534.78 : 612.85

6852. The reception of repeated and overlapping speech patterns. J. W. BLACK. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 494–7 (*May*, 1955).

Recorded nonsense syllables (CVC) were fed to the headsets of listeners via two channels simultaneously, a direct line and a line that introduced controlled amounts of delay from 0·00 to 0·33 sec. The amount of delay was varied in 0·03 sec increments and the effect of this variable upon the reception of the syllables was measured. Although the intervals of delay affected the reception scores differentially, no time of delay in the double presentations yielded intelligibility scores that were higher than the scores obtained through a single, direct playback of the stimuli. A.

534.784

6853. Development of a quantitative description of vowel articulation. K. N. STEVENS AND A. S. HOUSE. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 484–94 (*May*, 1955).

A set of parameters that yield a simple yet reasonably accurate description of the articulation of vowel sounds is developed. The articulatory description is potentially useful in a speech band-width compression system based on the coding of articulatory data. The parameters give information on the position of the tongue constriction, the size of the constriction formed by the tongue, and the dimensions in the vicinity of the mouth opening. An electrical analogue of the vocal tract is utilized to obtain experimental relations between the articulatory parameters and the formant frequencies. Contours of vowel articulation are derived from these data. The relation of the contours to classical phonetics is discussed. A.

534.784

6854. A difference limen for vowel formant frequency. J. L. FLANAGAN. Letter in *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 613–17 (*May*, 1955).

Experiments have been conducted to determine difference limens (DL's) for vowel formant frequency. The DL's are obtained from quality judgments on synthetic vowel sounds. The results indicate the maximum accuracy necessary in analysing the formant structure of spoken vowels and in synthesizing the sounds from the resulting formant data. A.

534.791/.793

6855. Objective and subjective loudness level measurements. G. QUIETZSCH. *Acustica*, **5**, 49–66 (1955) [= *Akust. Beih., No.* 1 (1955)] In German.

By means of 37 different noises comparative measurements on objective and subjective loudness level have been carried out. Taking as a basis the loudness summation method in eight octave bands (50 c/s to 12·8 kc/s) the still existing deviations of the loudness level found by this method from the real subjective level, and their relations to the distribution of loudness in the octave bands, have been studied. Simplified corrections can be given taking account of the masking in the lower octaves and the subjective increase of the loudness level by "loudness concentration" in the eighth octave. For the construction of an objective volume indicator a summation method with six bands is found to be most favourable if the five upper bands are equal width with respect to the "mel"-scale, whereas the lower one is of greater width. The effect of the ratio of peaks and the phase relations respectively on the loudness level has been studied by means of artificial noises. But this does not affect the practicability of the summation method. A.

534.793

6856. Measurement of difference in loudness between typing noises. J. ABRUZZO. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 457–60 (*May*, 1955).

It is difficult to ascertain the absolute loudness of typing noise by objective measurement. However, it may be practical to use such measurement to determine the loudness level difference in a comparison of the sounds from two typewriters. The requirements that must be met by an accurate measurement technique depend on the degree of accuracy required. Information pertaining to the accuracy necessary has been obtained by employment of two loudness matching procedures over a period of several months. The purpose of the tests was to determine the difference in sound-pressure level of typing noise necessary to enable a person to identify reliably the louder of two typewriters operated simultaneously in a quiet background. It was found that under the conditions adopted for the investigation, differences in sound-pressure level had to be nearly one decibel before they could be recognized 50% of the time. Characteristics of typing noise other than pressure level are discussed. The opinion is expressed that these will, in many cases, not cause significant measurement error, and that difference in loudness between typing noises can often be measured with practical accuracy by means of a sound-level meter. A.

534.833

6857. Experimental investigation of floating floors with sound bridges. M. HECKL. *Acustica*, **5**, *No.* 2, 112–18 (1955) In German.

According to a theory of L. Cremer the following factors are important for the insulation against airborne sound of floating floors with sound bridges: the natural frequency of the system floating floor and resilient layer, the resistance of the floor and covering, the propagation function in the floor and the transmission function of the supports. Methods of measuring these factors are given and, as example of the consonance between the theory (for an infinite floor) and practice, the measured values of resistance and propagation function in a 2 m² asphalt floor are quoted. The measured improvement in floating floors constructed with special supports also agrees with theory when the resistance of the covering is included. A.

534.833

6858. Acoustical behavior of some engine test cell structures. B. G. WATTERS, S. LABATE AND L. L. BERANEK. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 449–57 (*May*, 1955).

Presents some recent data on the acoustical behaviour of certain components of engine test cell structures. These data include information on (*a*) the directivity patterns of vertical stacks and (*b*) the noise reduction provided by some water spray systems, (*c*) the Soundstream absorber, and (*d*) a 90° vertical bend. A.

534.833

6859. Semiplastic earplugs. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 460–6 (*May*, 1955).

Description of the development of an earplug with soft elastic walls and a viscous core malleable at body temperature. The problems of suitable material, shape, and size are considered as well as the shape and size adaptability. People have found these earplugs sufficiently comfortable to sleep with, and they ensure a sound attenuation equal to or better than any known earplug. One size fitted 90% of the ears of the 25 people tested sufficiently well. A.

534.833 : 621.395.62

6860. Low-frequency sound reducer. *Electronics*, **28**, *No.* 6, 188, 190, 192, 194 (*June*, 1955).

In the sound absorbing system described, sound picked up by a microphone is amplified and fed to a loudspeaker in a phase relationship that tends to cancel out sound waves in the vicinity of the microphone. The microphone diaphragm is coupled to the anode rod of a movable-anode valve, giving a flat response down to 0 c/s. The system gives a high degree of sound pressure reduction between 20 and 200 c/s. W. G. STRIPP (R)

534.837

6861. Some results of experiments relating to the generation of noise in jets. L. W. LASSITER AND H. H. HUBBARD. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 431–8 (*May*, 1955).

Some sample experimental results relating to the nature and sources of noise in jets are presented. Previous work is extended to include more detailed information about the jet structure. In this regard noise data are compared for jets having somewhat different turbulence profiles. High-temperature jets are noted to have different radiation patterns and to be more efficient noise radiators than low-temperature jets. Noise data for the high-temperature supersonic jet of a rocket engine are included for comparison with those of subsonic jets. Some experiments have shown the noise levels at the low frequencies can be markedly reduced by the use of grids in the jet stream. A.

534.838 : 621.327.43

6862. On the noise of fluorescent lighting installations. E. W. VAN HEUVEN. *Acustica*, **5**, *No.* 2, 101–11 (1955).

In the frequency spectrum of the noise of a fluorescent lamp ballast, "hum" and "rustle" can be distinguished. Hum comprises small even multiples of the mains frequency, at which the dimensions of the ballast are small in comparison with the wavelength of the sound in the air. The noise at these frequencies is, therefore, mainly produced by the ballast acting as a vibration exciter to larger mounting surfaces. Rustle frequencies (1–3 kc/s) are radiated directly by the ballast itself. Hum may be eliminated by use of a core construction where the displacements due to magnetic attraction across the air-gap cancel out the magnetostrictive displacements at the mounting points of the reactor. Rustle radiation must be isolated by putting the ballast in a closed box. A filling for the empty space in these boxes providing acoustical impact sound insulation and good thermal conductivity is described. A.

534.84

6863. Making acoustical virtues out of architectural necessities. P. E. SABINE. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 497–500 (*May*, 1955).

534.851 : 535.417

6864. Calibration of test records by interference patterns. B. B. BAUER. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 586–95 (*May*, 1955).

This investigation stemmed from an attempt to explain the nature of the dispersion which occurs when a beam of light is reflected from a test record. Examination through colour filters revealed the existence of two distinct patterns of lines which the author has termed the *A*- and *B*-lines. *A*-lines are identified with the frequency and *B*-lines with the amplitude of the recorded sound. *B*-line patterns can readily be related to the modulation velocity of the record and they lead to a determination of the recorded velocity characteristic of a test record. Characteristics by conventional light patterns are found to be in error owing to the diffraction of light at the edges of the pattern. This error is ascertained by subtracting the modulation velocity by *B*-line patterns from that determined by conventional light-pattern techniques, and it is found to be of the order of magnitude of the calculated diffraction error from assumed triangular wavelets. Calibrations of representative test records by *B*-line patterns are in much better agreement than those obtained by conventional light patterns with the calibrations by the variable turntable technique, especially when the latter are corrected for the elastic deformation of the grooves owing to the pick-up load. A.

534.861 : 534.84 : 621.396.712.3(43)

6865. Room and building acoustics of the multi-purpose studios of the Hamburg broadcasting station. G. VENZKE. *Tech. Hausmitt. Nordwestdtsch. Rdfunks*, **6**, *No.* 11–12, 229–36 (1954) In German.

These studios are made up of two independent groups of rooms forming the ground and first floors of a special studio building. Each group consists of an anechoic room, a room with normal reverberation and one with variable reverberation. All the various means of effecting sound absorption, including multicellular surfaces, and of varying the absorption as desired are discussed. Some calculated and measured reverberation frequency characteristics are compared. The problem of sound insulation, including the construction of special doors, is also discussed.

H. G. M. SPRATT (R)

OPTICS . RADIATION . SPECTRA 535

535.214.6 : 538.61

6866. The theory of magnetophotophoresis. H. ROHATSCHEK. *Acta phys. Austriaca*, **9**, *No.* 2, 151–78 (1955) In German.

The existing theory of the "Ehrenhaft effect" is extended. The thermal fluctuations of the orientations of the permanent-magnet particles and the effect of the torque exerted on them by the photophoretic forces are considered. Conclusions are drawn as to the nature of the screw-like particle orbits, the dependence on field strength of the velocity component parallel to the field and the influence on this velocity of the thermal fluctuations, the relative importance of the magnetic and photophoretic torques and the change of the magnetic dipole axes of the particles. E. P. WOHLFARTH

535.245

6867. Accuracy of the Macbeth illuminometer as a function of operator variability, calibration, and sensitivity. A. MORRIS, F. L. MCGUIRE AND H. P. VAN COTT. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 525–30 (*July*, 1955).

The mean of a number of measurements from a number of operators gives a precise estimate of brightness. The most adequate measures are obtained when "calibration" amperage of the working lamp is carefully determined and maintained with precision. To establish the relation between the sensitivity of the eye and brightness measurements, the difference thresholds for lighter and darker were determined. The close similarity of the curves for the threshold data and for the brightness measurements demonstrates that "match" judgments are essentially discriminations of "lighter" and "darker." A.

535.247.4

6868. The behaviour of vacuum photocells for pulsed light illumination. W. KLUGE AND S. WEBER. *Z. angew. Phys.*, **7**, *No.* 3, 126–31 (1955) *In German.*

Ag–Cs_2O–Cs photocells can be used as proportional photometric detectors for single light pulses of very high intensity (10^7 lux). Repeated light pulses produce a reversible fatigue effect in the cells which is removed by infrared irradiation. G. F. J. GARLICK

535.247.4

6869. Self-extinguishing light meter with adjustable red limit. M. S. KHAÏKIN AND É. I. ABAULINA. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 254–6 (1955) In Russian.

To control the red limit of sensitivity of the photomultiplier a grid is placed near the photocathode.

To prevent the primary photoelectrons from acquiring speeds sufficient to produce a photoeffect on the grid, the distance from the photocathode is of the order of the mean free path, the filling gas being argon with 10% methylene mixture, at a pressure of 80 mm. Details are given of the construction of the photomultiplier, which has a tungsten retarding grid and an aluminium photocathode. The technique for making the tungsten grid by etching through a copper grid is given. Experiments are described, using Schott filters to determine spectrally the entering light from a quartz incandescent lamp, showing how the red limit of the light meter can be controlled by means of a retarding field between grid and photocathode. The sensitivity is some ten times less than that of an uncontrolled photomultiplier. J. EWLES

535.247.4

6870. Cosine-corrected photometer. F. HARTIG AND H. J. HELWIG. *Lichttechnik*, **7**, *No.* 5, 181–2 (*May*, 1955) In German.

Describes an illumination photometer in which the photovoltaic cell, which may be colour-corrected by means of a filter, is corrected for departures from the cosine law by covering it with a near-hemisphere of opal glass, the whole being surrounded with a flat collar of specially-designed profile. It is possible in this way to obtain correction to $\pm 2\%$ for all angles of incidence up to 85° or over. The sensitivity is 6×10^{-6} amp/lumen/ft^2. J. W. T. WALSH

535.31

6871. Construction of optically heterogeneous media from given beam paths. A. L. MIKAÉLYAN. *Zh. tekh. Fiz.*, **24**, *No.* 7, 1322–8 (1954) In Russian.

See also Abstr. 5377 (1953), 3259 (1954), and *Dokl. Akad. Nauk SSSR*, **86**, *No.* 5, 933–6 (1952) also Abstr. 8038 (1952). Analyses the case of isotropic heterogeneous media whose properties are determined by the law of phase velocity variation $v = v(x, y)$, the linear source of electromagnetic vibrations coinciding with the *oz* axis. The method of finding the relationships $v = v(x, y)$ corresponding with the given beam paths is developed for focusing media. F. LACHMAN

535.31

6872. Recent advances in optics. E. H. LINFOOT. *London*: *Oxford University Press* (1955) 294 *pp.* [*The International Series of Monographs on Physics.*]

"Provides the first account in book form of a number of important advances made in optical theory during the last fifteen years. It also includes a substantial amount of previously unpublished work. Chapter I is on the optical image. Chapter II is devoted to an account of the diffraction theory of the Foucault knife-edge test; Chapter III to the Schmidt camera and the field-flattened Schmidt camera. Chapter IV develops the technique of plate-diagram analysis."

535.31

6873. Is a light path always reversible? C. V. FRAGSTEIN. *Optica Acta*, **2**, *No.* 1, 16–22 (*April*, 1955) In German.

The reversibility of a light path has often been considered as a theory tenable without restriction. In fact, however, the reversibility cannot always be guaranteed when absorption is considered. The transparency of the boundary between two absorbing media is different in the two opposite directions and is (for normal incidence) $D_{1,2}/D_{2,1} = (1 + \kappa_1^2)/(1 + \kappa_2^2)$, where κ_1 and κ_2 are the indices of absorption of the media considered. The change of phase of a ray of light crossing such a boundary is also different for the two directions, whereas the changes of phase for the reflected part exactly as for the transparent media, differ by π for the opposite directions. In the same way the refraction of a ray of light falling obliquely on the boundary of two absorbing media is not reversible. For several metals (Ag, Au, Cu) there exists an angle of incidence at which the wave penetrating into the metal does not change its direction. If an homogeneous wave in the reverse direction from the interior of the metal is made to fall on the boundary, no angle of incidence exists at which the wave emerges into the air without being refracted. For other metals (Fe, Pt) emergence from the metal into air is possible without refraction but not in the reverse direction. A.

535.31 : 530.162

6874. Comparison between the transmission of information in optics and in radioelectricity. A. BLANC-LAPIERRE, M. PERROT AND G. PÉRI. *Optica Acta*, **2**, *No.* 1, 1–5 (*April*, 1955) In French.

The properties of the transformations which express the behaviour of the different parts of an optical system are compared with those of a radio-frequency circuit. The idea of "band-pass" applied to optics is discussed, together with that of limit of resolution. Ideal experiments are described offering the possibility of improvements in resolving power by applying to optics ideas originating in radio. Finally the introduction of an element of uncertainty corresponding in optics to that of noise is considered. This leads to the application of information theory to optics. A.

535.31 : 530.162

6875. Capacity of an optical channel in the presence of noise. G. TORALDO DI FRANCIA. *Optica Acta*, **2**, *No.* 1, 5–8 (*April*, 1955).

An optical instrument can be considered as a transmission channel. The capacity of the channel is evaluated by applying standard results of information theory. The instrument is assumed to be free from aberrations and colour is not taken into account. A.

535.31 : 535.12

6876. Geometrical optics of anisotropic media with one axis of symmetry. D. YU. GAL'PERN. *Zh. tekh. Fiz.*, **24**, *No.* 7, 1298–321 (1954) In Russian.

It is shown that the basic properties of the point, mixed, and angle eikonals remain valid, providing the object and image are in isotropic media. Under these conditions meridian and sagittal focal lengths are found, and Newton's law is satisfied. The laws of reflection and refraction at an interface are derived, and the astigmatism of narrow pencils treated. The applications include the case of a single lens made from a uniaxial crystal. H. H. HOPKINS

535.313

6877. Anamorphic mirror systems. A. BOUWERS AND B. S. BLAISSE. *Optica Acta*, **2**, *No.* 1, 36–42 (*April*, 1955).

New afocal anamorphic systems with cylindrical

mirrors are described. Image quality and distortion are discussed. Means of compensating the upward horizon distortion resulting from downward projection on a curved screen are given. A.

535.317

6878. One radius doublets. A. C. S. Van Heel. *Optica Acta*, **2**, *No.* 1, 29–35 (*April*, 1955).

It is proved that with a suitable choice of glasses a one-radius doublet has as good correction on the axis (for the object at infinity) as the best possible two-component thin system. The ratio of the indices of refraction for crown and flint must be 1 to 1·066. Coma is not corrected, but small. The influence of thicknesses is discussed. A.

535.317

6879. The Abbe condition and reversible optical transmission. P. M. Duffieux. *Rev. Opt.*, **34**, *No.* 5, 257–72 (*May*, 1955) In French.

The Abbe condition is shown to arise from the attempt to define a reversible transmission between object and observer. The harmonic theory of images and the Fourier transformation are used to extend the original meaning of the Abbe condition for incoherent light, when the condition is seen to be the code of partial transmission of the beam, between the appearances of the object and the image. R. W. FISH

535.317 : 666

6880. A practical method for the choice of glasses for a generalized cemented doublet. M. Corrias. *Atti Fond. Ronchi*, **10**, *No.* 2, 102–7 (*March–April*, 1955) In Italian.

Equations are obtained connecting the refractive indices of the glasses, the powers of the components and radii, when the coefficients of spherical aberration, coma and chromatic aberration are not zero. A typical example of their use is given and tables giving the curvatures as function of refractive indices are shown. R. W. FISH

535.317.25

6881. Use of spot diagrams to synthesize the image of resolving power test charts. N. Murcott and H. S. Gottfried. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 7, 582–3 (*July*, 1955).

An experiment is described allowing the recording of the image of a Cobb resolving target from the known spot diagram. Results are illustrated for a 20 in. lens, whose spot diagram was calculated from an interferogram. Some typical spurious resolution effects and image malformation are shown.

R. W. FISH

535.317.25 : 530.162

6882. Resolving power and information. G. Toraldo di Francia. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 497–501 (*July*, 1955).

The degrees of freedom of an image formed by any real instrument are only a finite number, while those of the object are an infinite number. Several different objects may correspond to the same image. It is shown that in the case of coherent illumination a large class of objects corresponding to a given image can be found very easily. Two-point resolution is impossible unless the observer has *a priori* an infinite amount of information about the object. A.

535.317.4

6883. The achievement of an objective with uniform field by means of apodization. R. Burtin. *Rev. Opt.*, **34**, *No.* 5, 273–80 (*May*, 1955) In French.

The aberrations of an objective can be corrected by diffraction, using an apodizing system. It is possible to find a plane in which the diffraction pattern on axis is similar to that at any off axis point. The relations between this plane and the aberrational coefficients are known as the isoplanatic conditions. These conditions are deduced for incoherent light, and are shown to be paradoxical. Some experiments with such a system are described, and these show that the uniform field can be achieved, although the system described is of little practical value because of its small aperture. R. W. FISH

535.33.03

6884. Emission spectrum of fused quartz excited by X-rays. Role of impurities and the vitreous state. M. Lautout. *J. Chim. phys.*, **52**, *No.* 2, 176–8 (*Feb.*, 1955) In French.

The emission spectrum extends from the short ultraviolet into the visible spectral region. The phosphorescence produced is little affected by impurities and appears to be characteristic of the vitreous state itself. See also Abstr. 6946–8 (1955).

G. F. J. GARLICK

535.33.03 : 538.6 : 537.525.5

Motion and spectrum of arc cathode spot in a magnetic field. *See Abstr.* 7079

535.33.07

6885. A near infrared spectrometer using a plane grating. Y. Sakayanagi and Y. Satô. *Science of Light* [*Tokyo*] **3**, *No.* 2, 84–9 (*March*, 1955).

A near infrared grating spectrometer based on the Littrow mounting is described, in which a PbS cell is used as the detector. The grating has 576 lines/mm and the focal length of the collimating mirror is 60 cm. The amplifier is constructed on the basis of the principle of Wilson's feedback, with a total gain of 120 db, and the bandwidth variable from 100 to 5 c/s. The source for the synchronous motor for rotating the chopper is supplied by the output of an RC-oscillator. A.

535.33.07

6886. Adaptation of a Perkin Elmer infrared spectrometer for use with long cells of small aperture. R. Coulon. Letter in *J. Phys. Radium*, **16**, *No.* 4, 343–4 (*April*, 1955) In French.

Uses a Zr arc source and a 50 cm long cell.

G. F. LOTHIAN

535.33.07

6887. Manual and continuous recording attachments for the Beckman Model DU spectrophotometer. G. L. Royer, H. C. Lawrence, S. P. Kodama and C. W. Warren. *Analyt. Chem.*, **27**, *No.* 4 (I) 501–6 (*April* 25, 1955).

This spectrophotometer has found wide application in the field of visual and ultraviolet spectrophotometry. To reduce the time required to plot a spectral curve with this instrument, the authors built a manual plotting attachment which would record the data from the spectrophotometer directly on a plotting

paper. This saves time but suffers from the inherent disadvantages of point-by-point plotting in that one can only obtain spaced points on the curve. The continuous recording attachment described in this paper has the advantage of giving a complete record of the per cent transmittancy at all wavelengths through which the instrument is operated. A.

535.33.07

6888. High-resolution spectroscopy in the 3–5 micron region with a small grating spectrometer. R. C. Lord and T. K. McCubbin, Jr. *J. Opt. Soc. Amer.*, **45**, *No.* 6, 441–6 (*June*, 1955).

A 150-line-per-mm grating has been installed in double-pass monochromator. With a lead-telluride cell as detector and a selenium-coated germanium filter to remove higher orders, high-resolution spectra have been measured over the range 3–5 μ. Rotational fine structure spacings of $0{\cdot}3\,cm^{-1}$ or less have been resolved, and wave-numbers measured with a precision of $0{\cdot}1\,cm^{-1}$ or better. Calibration was done by means of higher orders of atomic lines, chiefly neon and argon. Precision of the measurements was sufficient to demonstrate that published data on methane and carbon dioxide in this region contain random errors. As an example of the usefulness of the instrumentation, it may be mentioned that rotational fine structure in cyclopropane and cyclopropane-d_6 has been easily resolved and the C-C distance in the molecule determined as $1{\cdot}524 \pm 0{\cdot}014$Å. A.

535.33.07 : 535.339.4

6889. A "Wechsellichtmonochromator" for spectral lines from extended sources. G. Ehgartner, W. Piepenbrink and H. Maier-Leibnitz. *Z. Phys.*, **141**, *No.* 1–2, 246–53 (1955) In German.

Light from the source is reflected at 45° from a Fabry Pérot etalon with small air gap through a lens in the focal plane of which is a diaphragm made by photographing *in situ* the fringe pattern formed when monochromatic light is used. The diaphragm is vibrated at 20 c/s and the transmitted beam passes to a photomultiplier, amplifier and commutator synchronized with the vibrator. The output will be a max. if the light has a λ equal to that used for preparing the diaphragm. For other λs where the fringes are out of step with the diaphragm the output will be reduced; the arrangement thus acts as a filter. If the etalon spacing is changed by a micrometer screw various λs in turn come into step with the diaphragm and the arrangement becomes a monochromator. Tests on a Cd arc and a diaphragm with 176 rings show a resolution better than 100 Å.

G. F. LOTHIAN

535.33.07 : 537.542

Photon counters for the far ultraviolet. *See Abstr.* 7140

535.331

6890. Shifts and asymmetries in condensed spark spectra of electroplated electrodes. L. Blitzer. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 564–7 (*July*, 1955).

Some effects in the spectra of individual sparks between copper electrodes electroplated with thin deposits of silver were studied with the aid of a time-resolving spectrograph. The initial phase of the discharge is characterized by short-lived broadened lines of N II and O II, plus an intense continuum. The line spectrum is predominantly that of Ag II with but a few lines of Ag I present. All of the high-level lines of Ag II, and only these lines, are initially asymmetrically broadened and shifted to the red, but return to their normal wavelength positions after 6–9 μsec; while the low-level lines are characterized by self-reversal and associated continuum. The strong similarity to the spectrum of exploding Ag wire indicates that the same mechanism is operative in both. These effects are explained in terms of a Stark effect induced by the fields of neighbouring electrons and ions. A.

535.332 : 539.152.2

Hyperfine structure and nuclear moment of Kr^{85}. *See Abstr.* 7292

535.333

6891. On the emission spectra of the β-, γ- and ε-systems of nitric oxide. M. Ogawa, *Science of Light* [*Tokyo*] **3**, *No.* 2, 90–128 (*March*, 1955).

Emission spectrum of the nitric oxide molecule was photographed in the region of $6\,500 \sim 1\,950$ Å, using direct electrical excitation of flowing NO gas. Some new bands of the β- and γ-systems were observed. A rotational analysis was made of the nineteen bands of the γ-system, including a new analysis of the (1–6), (2–6), (2–7), (2–8) and (5–5) bands. The intensities of the bands with $v' \geqslant 4$ of the γ-system were anomalously strong as were also anomalously large the rotational constants of $v = 4$ and 5 levels of the $A^2\Sigma^+$ state. It was concluded that the $D^2\Sigma$ state (upper state of the ε-system) does exist, that the observed emission bands with $v' \geqslant 4$ belong to the ε-system, and that Herzberg and Mundie's assumption for the γ- and ε-systems does not apply. The rotational and vibrational constants of the $D^2\Sigma$ state are as follows: $B_0 = 1{\cdot}99_0\,cm^{-1}$, $B_1 = 1{\cdot}97_2\,cm^{-1}$, $B_e = 1{\cdot}99_9\,cm^{-1}$, $\alpha = 0{\cdot}01_8\,cm^{-1}$, $r_e = 1{\cdot}06_3 \times 10^{-8}$ cm, $\omega_e = 2\,327\,cm^{-1}$, $\omega_e x_e = 24\,cm^{-1}$ and $\nu_e(D^2\Sigma - X^2\Pi) = 53\,083\,cm^{-1}$. The Λ-type doubling of the $X^2\Pi_{3/2}$ state was negligibly small and that of the $X^2\Pi_{1/2}$ state small but not negligible and increased linearly with the rotational quantum number, showing qualitative agreement with theoretical results. The coupling constant A of the $X^2\Pi$ state decreases with the vibrational quantum number. In the visible region, the bands with $v' = 5$ and 6 of the β-system were observed but a clear decrease of their intensities, expected from Kaplan's suggestion, was not observed. A.

535.333

6892. On the emission intensities of the O_2 atmospheric bands ($b^1\Sigma_g^+ \rightarrow X^3\Sigma_g^-$). M. Shimazu. *Science of Light* [*Tokyo*] **3**, *No.* 2, 129–42 (*March*, 1955).

The relative intensities of the (0–0) and (1–1) bands of the atmospheric oxygen bands obtained in electric discharge were measured; the procedure is described. Vibrational and rotational temperatures were measured, and showed good agreement. Assuming the thermal distribution of the excited molecules, the relative intensities of many bands belonging to this system were calculated for the temperature range of $400° \sim 5\,000°$K. Results of several experiments on

the emission of the atmospheric bands reported up to the present time are discussed on the basis of the present results. A.

535.333

6893. Spectroscopic identification of diatomic PS and new band systems of PO and P_2. K. DRESSLER AND E. MIESCHER. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 542–4 (*June*, 1955).

Constants (cm^{-1}) obtained from vibrational analyses of emission bands are as follows:—

	$\nu_{0,0}$	ω'_e	$x'_e\omega'_e$	ω''_e	$x''_e\omega''_e$
PO	53 320·8 53 096·0	$\Delta G'_{1/2} = 1454{\cdot}5$		1 233	7
PS	34 587·0 34 265·6	534	3	740	3
PS^+	40 499·0	610	5	845	3·5
P_2	66 275	680	—	772	—
	59 407	—	—	770	—

R. F. BARROW

535.333

6894. Intensities in band systems of CH. M. E. PILLOW. *Proc. Phys. Soc. A*, **68**, *Pt* 6, 547–8 (*June*, 1955).

Relative transition probabilities are calculated for bands of the ^2A, B, C–X systems. R. F. BARROW

535.338.332

6895. On a method of changing the occupation numbers of hyperfine structure terms of the sodium ground state. H. BUCKA. *Z. Phys.*, **141**, *No.* 1–2, 49–58 (1955) In German.

The atom is irradiated with Doppler-displaced light from the two Na D-lines. The displacement is half the hyperfine structure splitting of the ground term, and consequently excites only one of the terms. Proof of the change is given by the change in intensities of the resonance radiation. G. E. BROWN

535.338.332

6896. Hyperfine structure of spectral lines and spins of the nuclei U^{233} and Pu^{239}. L. A. KOROSTŸLEVA, A. R. STRIGANOV AND N. M. YASHIN. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 471–9 (1955) In Russian.

The hyperfine structure of twelve lines of U^{233} is studied. In four of these, a complete six-component structure is found indicating a spin of 5/2. Presence of a quadrupole moment is detected. In Pu^{239} 70 lines with a doublet structure are observed, giving a spin of 1/2. G. E. BROWN

535.338.332 : 539.152.2

6897. The hyperfine structure of the resonance lines of ytterbium II. K. KREBS AND H. NELKOWSKI. *Z. Phys.*, **141**, *No.* 1–2, 254–62 (1955) In German.

The line 3 694 Å was examined with a Perot interferometer. The splitting factors of Yb^{173} gave a new value for the magnetic moment and new values for the experimental isotopic shift constants were also determined. Preliminary investigations show that the line 3 289 Å will lead to results in agreement with present ones. J. JACOBS

535.338.332 : 539.152.2

6898. Determination of the electrical quadrupole moment of the nuclei Rb^{85} and Rb^{87} by measurement of the high-frequency transition in the excited $6^2P_{3/2}$-term of the rubidium atom. U. MEYER-BERKHOUT. *Z. Phys.*, **141**, *No.* 1–2, 185–97 (1955) In German.

A more extensive account of the experimental procedure is given here than was in the first brief note reporting the results [see Abstr. 4520 (1955)]. J. HUGHES

535.338.333

6899. On the isotopic shift in the Cu I spectrum. S. WAGNER. *Z. Phys.*, **141**, *No.* 1–2, 122–45 (1955) In German.

The isotopic shift was examined using Cu^{63} and Cu^{65}. A uniform scheme emerged which attributes shifts to the terms concerned with the transitions. Terms belonging to an electron configuration $3d^{10}$ behave in a significantly different way from those of $3d^9$. The coupling effect of nuclear movement is considerably greater in the former if the shifts are suitably normalized. On the basis of this theory of coupling effects it is possible to attribute this difference to the missing $3d$–$2p$, $3d$–$3p$ couplings. J. JACOBS

535.338.333

6900. Isotope shift in the spectrum of plutonium. A. R. STRIGANOV, L. A. KOROSTŸLEVA AND YU. P. DONTSOV. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 480–4 (1955) In Russian.

A mixture of Pu^{239} and Pu^{240} is investigated with high resolving power between 4 100–6 500 Å. Nineteen lines exhibit an isotope shift; some of these, hyperfine structure. Schemes of transitions are proposed. G. E. BROWN

535.338.333

6901. Configurational mixing and isotope shift in the Gd II spectrum. P. BRIX AND K.-H. LINDENBERGER. *Z. Phys.*, **141**, *No.* 1–2, 1–5 (1955) In German.

The Gd II spectrum is investigated between 3 671 and 3 856 Å. The $4f^7 6s6pz^{10}$ P-term has an anomalously small isotope shift. This is interpreted as a ~29% mixture of $4f^7 5d6p$ into the z^{10}-P terms. This is in good agreement with theoretical calculations of Zeldes [Abstr. 4701 (1953)], who calculates the mixing from the term values. G. E. BROWN

535.338.333

6902. Isotope shift in the hafnium II spectrum. E. FINCKH AND A. STEUDEL. *Z. Phys.*, **141**, *No.* 1–2, 19–27 (1955) In German.

The Hf II spectrum between 2 600 and 3 800 Å was investigated with a Fabry–Pérot interferometer. Sixteen lines show a doublet structure, which is interpreted as an isotope shift between Hf^{178} and Hf^{180}. The experimental isotope-shift constant is $\beta C_{exp.} = (111 \pm 13) \times 10^{-3} cm^{-1}$, which fits in well with results for other elements in this range. G. E. BROWN

535.338.333

6903. Isotopic shift in the λ 4 416 Å line of Cd II. J. BLAISE. *Z. Phys.*, **141**, *No.* 1–2, 87–90 (1955) In French.

A new measurement of the hyperfine structure with a photoelectric Fabry–Pérot spectrometer. Taking the interval Cd 110–112 as 1, relative isotope positions for 106–116 are reported, between $-2{\cdot}02 \pm 0{\cdot}06$ to $2{\cdot}56 \pm 0{\cdot}07$. J. JACOBS

535.338.333 : 539.153

6904. An approximation method for determining the screening effect from the isotopic shift of spectral lines. W. HUMBACH. *Z. Phys.*, **141**, *No.* 1–2, 59–69 (1955) In German.

A perturbation method for many-electron problems with spherical symmetry is developed. The perturbation of the Hg^{++} ion by the 6 *s*-electrons of the Hg atom is carried out numerically, leading to a screening factor $\beta = 0{\cdot}98 \pm 0{\cdot}02$ for Hg. J. JACOBS

535.338.334

6905. Theory of the breadth of atomic spectral lines. I. I. SOBEL'MAN. *Uspekhi fiz. Nauk*, **54**, *No.* 4, 551–86 (1954) In Russian.

A survey of the theory of broadening of spectral lines due to interaction of a radiating atom with the particles (atoms, molecules, ions, electrons) surrounding it. The paper may be considered a successor to the surveys of Weisskopf (1933), Margenau and Watson (1936), Unsold (1943). The article gives the classical treatment of impact theory (Lorenz, Lenz, Weisskopf), a study of statistical theory (Holtzmark, Margenau) with a discussion of these and of the role of the Döppler effect in broadening lines (Burkhardt, Spitzer, Sobelyev, Foley, Gintsburg, Sobel'man). There follows an analysis of the laws of interaction–time dependence of a perturbation, charged particle interaction, van der Waals' interaction of neutral atoms (Frank, Condon), broadening in a homogeneous gas (Weisskopf, Vensov, Fursov). The last section deals with a quantum-mechanical generalization of the theory (Yablonskiĭ). 60 references.

C. R. S. MANDERS

535.338.334 : 537.228.5

6906. Broadening of the lines of Na I under the influence of the intermolecular Stark effect. S. WENIGER AND R. HERMAN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1876–8 (*May* 9, 1955) In French.

The profiles of lines emitted in condensed sparks between Na electrodes in an atmosphere of H_2 are studied. Electron concentrations derived from measurements of H lines are greater than those from lines of Na I. R. F. BARROW

535.338.4

6907. Fine structure of NO^+ and NO emission spectra in the Schumann region. E. MIESCHER. Letter in *Canad. J. Phys.*, **33**, *No.* 6, 355–6 (*June*, 1955).

Rotational analyses lead to the following constants (cm^{-1}):

		T_e	ω_e	$x_e\omega_e$	r_e, Å
NO^+	$A^1\Pi$	73 469·6	1 608·9	23·3	1·192 6
	$X^1\Sigma^+$	0	2 377·1	16·35	1·061 9
NO	$B^2\Delta_i$	60 365	1 216·2	16·4	1·303

R. F. BARROW

535.34.07

6908. Extreme resolution of infra-red absorption spectra. J. H. JAFFE, T. A. WIGGINS AND D. H. RANK. Letter in *Nature* [*London*] **175**, 908 (*May* 21, 1955).

A grating spectrometer used near $\lambda = 1{\cdot}5\,\mu$, gives a resolution of $0{\cdot}18\,cm^{-1}$ and when crossed with an etalon, of $0{\cdot}045\,cm^{-1}$. G. F. LOTHIAN

535.342

6909. Theoretical study relating to ideas of intensity and width of absorption lines. VINCENT-GEISSE. *Ann. Phys.* [*Paris*] **10**, 185–200 (*March–April*, 1955) In French.

For gaseous absorption lines of Lorentz shape where the absorption coefficient $k_\nu = A/[B + (\nu - \nu_0)^2]$, it is shown that the intensity α of the line $\left(\int_\delta^D k_\nu d\nu\right)$ may be deduced from transmission measurements (t) with a monochromator with slit width ($a\,cm^{-1}$) greater than the line width. α equals, to about 12%, the limit as path length $l \to 0$ of $a(l-t)/1$. The conditions necessary to permit reliable extrapolation to $l = 0$ are investigated. A similar extrapolation to zero pressure at fixed l is possible but is only reliable if $a < 0{\cdot}1\,cm^{-1}$. Extension to several lines such as a complete rotation-vibration band is considered. Experimental verifications will be considered later. G. F. LOTHIAN

535.343 : 535.372 : 545.82

6910. On the spectroscopic behaviour of methyl derivatives of naphthalene and on the problem whether position isomers of derivatives of aromatic hydrocarbons can be analysed spectroscopically. H. C. WOLF. *Z. Naturforsch.*, **10a**, *No.* 4, 270–8 (1955) In German.

The absorption and fluorescence spectra of a large number of methyl derivatives of naphthalene were measured. Former results were confirmed. The spectra of the methyl derivatives are very similar to that of naphthalene, apart from transition *I*, which is allowed in the derivatives, but forbidden in naphthalene. The spectra of the various derivatives differ in secondary vibrations. In a few cases these differences are sufficient for the determination of the derivative from the spectrum. The theory of spectroscopic moments can be applied successfully to naphthalene. This makes it possible to divide the derivatives into classes of the same spectroscopic moment, but it is difficult to distinguish between the spectra of derivatives of the same class. A. J. TAYLOR

535.343

6911. Interaction of methylene deformation frequencies in paraffin crystals. II. A theoretical treatment of the interaction of vibrations. R. S. STEIN. *J. chem. Phys.*, **23**, *No.* 4, 734–6 (*April*, 1955).

For Pt I, see Abstr. 3128 (1953). The splitting of the methylene deformation frequencies in crystals of *n*-paraffins is described in terms of interaction between nearest-neighbour molecules. On the basis of a simplified model, the order of magnitude of the splitting may be accounted for. Polarization behaviour and changes occurring upon heating, cooling, and deuteration are described in terms of this model. A.

535.343

6912. The absorption spectrum of nitric oxide in the far-ultraviolet region. M. UEDA. *Science of Light* [*Tokyo*] **3**, *No.* 2, 143–55 (*March*, 1955).

The absorption spectrum of nitric oxide was photographed under various pressures in the far ultraviolet region (1 800 Å–1 300 Å), using a 3 m grazing incidence vacuum spectrograph. The recently found states, i.e.

the $E^2\Sigma$, B' and B'' were reinvestigated. Vibrational levels of the $E^2\Sigma$ were confirmed up to $v' = 5$ and a formula obtained that conformed with their heads. In order to analyse the pairs of heads that presented aspects similar to the β'-system, a new interpretation of the β'' and an extension of the β'-progression is proposed. A progression, which the author named *S*, with vibrational constants and an appearance of the head closely resembling the β-system is newly analysed. A few other progressions are also listed as tentative proposals. A.

535.343

6913. Absorption of the vapour of heavy water in the Schumann ultraviolet. A. JOHANNIN-GILLES. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 14, 1523–5 (*April* 4, 1955) In French.

The long-wave absorption limit is 30 Å shorter than for H_2O vapour; but the positions of the peaks are the same, indicating that each peak is a separate electronic transition. G. F. LOTHIAN

535.343 : 535.371

6914. A new effect connected with the luminescence and the 2400 Å absorption band of vitreous silica. V. GARINO-CANINA. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1331–3 (*March* 21, 1955) In French.

Vitreous silica heated to 1000°C between Pt electrodes with electric field applied shows after cooling down a loss of the 2400 Å absorption and of the 2537 Å excited luminescence in anodic regions and movement of colour bands towards the cathode with heating. G. F. J. GARLICK

535.343 : 535.371

6915. On the nature of absorption centres in vitreous silica. V. GARINO-CANINA. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1765–7 (*May* 2, 1955) In French.

The observed band at 2400 Å in vitreous silica and its characteristics (see preceding abstract) suggest that it be attributed to interstitial silicon atoms.

G. F. J. GARLICK

535.343

6916. Low resolution electronic spectrum of hexamethylbenzene with application to benzene. R. C. NELSON AND W. T. SIMPSON. *J. chem. Phys.*, **23**, *No.* 6, 1146–51 (*June*, 1955).

The crystal spectrum of hexamethylbenzene has been obtained using polarized light in the region 1725–2800 Å and the results including extinctions for out-of-plane absorption are interpreted. The vapour spectrum has been determined in the region 1300–2800 Å and the solution spectrum down to 2150 Å. The vapour spectrum shows a new band at 2350 Å. A suggestion is made for determining quantum numbers in the Rydberg series formula. A.

535.343

6917. Pure rotational spectrum of H_2Se between 50 and 250 cm^{-1}. E. D. PALIK. Letter in *J. chem. Phys.*, **23**, *No.* 5, 980–1 (*May*, 1955).

This spectrum was observed in the far infrared. It consisted of a series of strong lines with constant spacing with some weaker lines in between. This strong series was identified with transitions between low τ levels, some of the weaker lines with high τ transitions. The pure rotational spectrum could be calculated from these data and other lines could be assigned. The molecular constants were calculated. As there are several isotopes of Se, there is a slightly different rotation spectrum due to each. A. J. TAYLOR

535.343

6918. Infrared spectrum of iridium hexafluoride. H. C. MATTRAW, N. J. HAWKINS, D. R. CARPENTER AND W. W. SABOL. Letter in *J. chem. Phys.*, **23**, *No.* 5, 985–6 (*May*, 1955).

The six vibration frequencies of the O_h symmetry are deduced from observations. G. F. LOTHIAN

535.343

6919. Infrared study of the water in the $Li_2SO_4 . H_2O$ crystal. E. DROUARD. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1700–2 (*April* 25, 1955) In French.

Data given by infrared measurements give the direction of the OH-group with a rather large margin of error. A hypothesis on the position of the water molecule is given agreeing with these results, but only partly agreeing with the nuclear magnetic resonance measurements. C. TURNER

535.343

6920. Induced infrared absorption in gaseous acetylene at pressure. R. KIYAMA, S. MINOMURA AND K. OZAWA. *Proc. Japan Acad.*, **30**, *No.* 8, 758–63 (*Oct.*, 1954).

The i.r. spectrum of gaseous C_2H_2 was measured at pressures up to 24 kg/cm² between 1100–5800 cm^{-1} at room temperature. At high pressures the 1974 cm^{-1} band of the symmetrical fundamental ν_2, which is forbidden in infrared, was visible. The 1328 cm^{-1} ($\nu_4 + \nu_5$) was also observed when the gas was pressurized with oxygen up to 20 kg/cm². The i.r. absorption of C_2H_2 increased with increase of pressure of the foreign gas. This is caused by the distortion of the electronic charge distribution.

A. J. TAYLOR

535.343 : 532.73–1

6921. Contribution to the study of solutions of gases by infrared spectrography. G. PAILLARD. *J. Phys. Radium*, **16**, *No.* 4, 281–5 (*April*, 1955) In French.

The vibration-rotation spectra of CH_4 and C_2H_2 have been measured as gases and in solution in CCl_4 and CS_2. The fine structure disappears in solution indicating that rotation is hindered by molecular interactions. The bands are displaced in solution by amounts up to 180 cm^{-1} which vary irregularly from band to band, but which are comparable for both solvents; these effects are unexplained and more experimental data are needed on simpler molecules. G. F. LOTHIAN

535.343

6922. Infrared absorption spectra of thiophene and mono- and di-substituted derivatives. (Assignment of vibration modes of the measured bands.) A. HIDALGO. *J. Phys. Radium*, **16**, *No.* 5, 366–72 (*May*, 1955) In French.

This spectrum was taken between 2 μ and 25 μ, and assigned with the use of the depolarization of the Raman lines and by comparison with related molecules like cyclopentane, cyclopentene, pyrrole, furane, and selenophene. The spectra are discussed in detail.

It was found that the spectra of the various compounds give a good account of the similarities and differences between the molecules. A. J. TAYLOR

535.343

6923. Use of partially oriented solid samples and unpolarized radiant energy in the analysis of infrared absorption spectra. J. E. STEWART. Letter in *J. chem. Phys.*, **23**, *No.* 5, 986–7 (*May*, 1955).

Comparison of oriented and powdered para-dichlorbenzene shows that 818 cm^{-1} is a σ_{14} CCl stretching vibration. G. F. LOTHIAN

535.343

6924. Isotopic effect in trichlorofluoromethane. A. HADNI. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1983–5 (*May* 16, 1955) In French.

The absorption band of trichlorofluoromethane gas at 535·9 cm^{-1} is thought to be a triplet, the component lines of which are 2·1 cm^{-1} apart. These are attributed to the isotopic derivatives $CFCl_2^{35}$, $CFCl_2^{35}Cl^{37}$, and $CFCl^{35}Cl_2^{37}$ which are present in the gas in the quantities 45·8%, 40·8% and 12·1% respectively. G. I. W. LLEWELYN

535.343

6925. Contemporary state of radio-spectroscopy. M. A. YEL'YASHEVICH. *Uspekhi fiz. Nauk*, **54**, *No.* 4, 513–49 (1954) In Russian.

A survey article well illustrated with sketches and schematics and quoting 52 up-to-date references. Section 1 deals with transitions between energy levels in the absence of an external field: electron transitions, rotational transitions, transitions caused by interactions within molecules, hyperfine structure and transitions connected with the spin of nuclei. Section 2 deals with sub-level Zeeman splitting: transitions caused by electronic, nuclear and rotational magnetic moments. A further section discusses the principles of experimental methods used in radio-spectroscopy: absorption in gases studied with microwave spectrographs, magnetic resonance in liquids and solids, quadrupole transitions in solids, electrical resonance of molecular beams. The last section summarizes results to date for nuclei, atoms, molecules, solids and liquids. C. R. S. MANDERS

535.343 : 535.515 : 538.614

6926. On some magneto-optical phenomena related to the molecular resonance of gases in the hyper-frequency region. A. GOZZINI. *J. Phys. Radium*, **16**, *No.* 5, 357–9 (*May*, 1955) In French.

A general and theoretical review of the magnetic birefringence and Faraday effects to be expected at or very near to a microwave molecular rotation transition. For the $(J, K) = (3, 3)$ inversion line of NH_3 the maximum rotations should be 51′ and 26′ per metre respectively for the two effects at 5000 gauss. The sign of the Faraday rotation indicates the sign of the molecular g factor. D. H. WHIFFEN

535.343

6927. Analysis of spin-spin multiplets in nuclear magnetic resonance spectra. H. M. MCCONNELL, A. D. MCLEAN AND C. A. REILLY. *J. chem. Phys.*, **23**, *No.* 6, 1152–9 (*June*, 1955).

A systematic procedure is developed for the analysis of the spin–spin multiplets that are observed in the high-resolution NMR (nuclear magnetic resonance) spectra of liquids. It is shown how the symmetry properties of nuclear spin functions can be used to simplify the interpretation of NMR multiplets in terms of the empirical quantities, chemical shifts and spin-spin coupling constants. It is also pointed out that when NMR multiplets have been properly interpreted in terms of these empirical quantities, it is then possible to predict theoretically relative intensities of multiplets to the same degree of precision as that involved in the measurement of multiplet frequency separations. As an example the multiplet splittings of the H^1 and F^{19} resonances in 1, 1-difluoroethylene are analysed using the procedure. A.

535.343 : 538.615

6928. The Zeeman effect in ammonia microwave spectra. Y. TORIZUKA, Y. KOJIMA, T. OKAMURA AND K. KAMIRYO. *J. Phys. Soc. Japan*, **10**, *No.* 6, 417–20 (*June*, 1955).

The microwave Zeeman effect of $N^{14}H_3$ inversion spectra was investigated at strong magnetic field to observe molecular g-factor in the decoupled state of spin-rotation interaction. The result on $J, K = 1, 1$ line shows the transition from Zeeman effect to Paschen–Back effect near 10000 Oe. The obtained molecular g-factors for several different JK values give some information on g-factor of $N^{14}H_3$ both parallel and perpendicular to the molecular axis. A.

535.343

6929. Microwave spectrum of carbon monsulfide. R. C. MOCKLER AND G. R. BIRD. *Phys. Rev.*, **98**, *No.* 6, 1837–9 (*June* 15, 1955).

CS was produced by an electrical discharge through CS_2 and continuously flowed through a conventional Stark spectrometer. The $J = 0 \rightarrow 1$ transitions of the isotopic species $C^{12}S^{32}$, $C^{12}S^{33}$, $C^{12}S^{34}$ and $C^{13}S^{32}$ were observed in their vibrational ground states. $C^{12}S^{32}$ was also observed in its first excited vibrational state. The spectra yield the following molecular constants (in Mc/s):

$$B_e(C^{12}S^{32}) = 24584{\cdot}352 \pm 0{\cdot}015,$$
$$B_e(C^{12}S^{33}) = 24381{\cdot}011 \pm 0{\cdot}027,$$
$$B_e(C^{12}S^{34}) = 24190{\cdot}198 \pm 0{\cdot}014,$$
$$B_e(C^{13}S^{32}) = 23205{\cdot}215 \pm 0{\cdot}020,$$
$$\alpha(C^{12}S^{32}) = +177{\cdot}544 \pm 0{\cdot}026,$$
$$eqQ(C^{12}S^{33}) = +12{\cdot}835 \pm 0{\cdot}026.$$

Dipole moment = 1·97 ± 0·02 Debye units, equilibrium bond distance = 1·5349 ± 0·0002 Å, where B_e = equilibrium rotational constant, α = vibration-rotation interaction constant, and eqQ = electric quadrupole coupling constant. The mass ratios calculated from the above B_e values are: $S^{32}/S^{34} = 0{\cdot}941\,246 \pm 22$, $S^{32}/S^{33} = 0{\cdot}969\,6909 \pm 32$, and $C^{12}/C^{13} = 0{\cdot}922\,8447 \pm 20$. Nuclear magnetic interactions of S^{33} were also detected. The coefficient C of the $CI \cdot J$ coupling term was found to have the value 0·019 ± 0·015 Mc/s. A.

535.345.6 : 535.41 : 535.51

6930. Interference polarizational light filter for the *K*-lines of ionized calcium. A. B. GIL'VARG, G. I. DISTLER AND E. A. MAKAROVA. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 6, 1067–8 (1955) In Russian.

A filter for the K-line 3933·7 Å of ionized calcium has been developed containing 9 quartz elements and

10 polarizers, the latter of a special film type developed by the USSR Academy of Science's Crystallographic Institute, having a transparency of about 36% at 3933·7 Å, and a degree of polarization of the transmitted light of about 98%, considerably better than the usual polaroid filter based on polyvinyl alcohol [nature of film unstated]. The calculated half-width for the transmission of the filter around 3933·7 Å is 1·5 Å and the transparency of the block of 10 polarizers, combined with a special glass filter, is 1·6%. The coefficient of transmission of the complete filter, in the centre of the transmission band, is 1·2%, and the half-width derived from an analysis of spectrograms, 0·9 Å. Exposures of 0·5–1 sec were sufficient to give records of the *K*-line from protuberances on the sun's disk, on which photometric measurements could be made. R. C. MURRAY

535.361.1

6931. On the question of the dispersion of light by matt glasses. A. A. GERSHUN AND O. I. POPOV. *Svetotekhnika*, **1**, *No.* 1, 3–7 (*Feb.*, 1955) In Russian.

The theory is developed for the case of parallel rays falling on the polished side. Experimental measurements were made. It is concluded that matt glass may be represented by an infinity of humps and hollows with faces directed in different directions. The number of faces and their angles of inclination to the macro-surface were determined by the distribution function of the glass, which also mainly determines the distribution of transmitted energy. From knowledge of the distribution function it is possible to calculate theoretical indices of brightness of the matt glass for different practical applications. The distribution function of mechanically produced matt glass can be represented as a curve which is a function of two parameters, a main one and a subsidiary one which only influences the shape of the distribution function when the angle of incidence is 30°–40°. The empirical formula is

$$F(\delta) = (1 + a \tan^4 \delta)/(1 + k \tan^2 \delta)$$

where k is the main parameter and a is the subsidiary parameter, both of which are determined experimentally. The simplified formula

$$F(\delta) = 1/(1 + k \tan^2 \delta)$$

may be used in most cases. W. R. STOKER

535.371

6932. Yield of resonance luminescence of atoms. M. N. ALENTSEV, V. V. ANTONOV-ROMANOVSKIĬ, B. I. STEPANOV AND M. V. FOK. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 253–4 (1955) In Russian.

Mainly a restatement of the effect of thermal deactivation on efficiency, on well-known lines previously suggested by von Hippel, Mott and others, and leading to a similar expression to that obtained by them for the temperature quenching of luminescence. J. EWLES

535.371

6933. Dependence of fluorescence on the structure of the solvent molecule. E. J. MILER. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 107–11 (*March*, 1955).

The fluorescence intensity as a function of the composition of solvent molecules has been investigated. Although the absorption of radiation in the solution is increased by the introduction of a heavy atom substituent into the solvent molecule, the fluorescence is quenched. The excitation energy is not transferred to the fluorescent molecule, but is quenched in the solvent molecule by electronic perturbations and steric hindrances. Tables of relative fluorescence intensity are given. A.

535.371

6934. Action of nickel and cobalt on ZnS(Au) phosphors. Displacement of Fermi level by variation in concentration. N. ARPIARIAN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1333–5 (*March* 21, 1955) In French.

Ni and Co at small concentrations enhance the ZnS–Au emission as in the case of Fe impurity. See also Abstr. 5334 (1955). G. F. J. GARLICK

535.371

6935. Mounting of a NaI–Tl crystal in an air-tight case. B. MOUGIN. Letter in *J. Phys. Radium*, **16**, *No.* 4, 339 (*April*, 1955) In French.

535.371

6936. Relative intensities of anthracene and naphthacene emissions under cathode ray, ultraviolet, and X-ray excitations. B. D. SAKSENA AND L. M. PANT. Letter in *J. chem. Phys.*, **23**, *No.* 5, 987–8 (*May*, 1955).

535.371

6937. Luminescence of crystals at low temperatures. VII. *T* to *S* transition of benzene. P. PESTEIL AND L. PESTEIL. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1987–9 (*May* 16, 1955) In French.

For Pt VI, see Abstr. 4550 (1955).

535.371 : 535.51

6938. Elliptically polarized fluorescence in optically active compounds. O. NEUNHOEFFER AND H. ULRICH. *Z. Elektrochem.*, **59**, *No.* 2, 122–6 (1955) In German.

Excitation of the sodium salt of optically active 1 : 3 : 5 triphenylpyrazolinsulphonate with unpolarized or linearly polarized light produces a strong elliptically polarized emission. Solution of the salt in glycerine shows a similar effect with linearly polarized light. An explanation of the effect is given. G. F. J. GARLICK

535.371 : 537.312.5

6939. Infrared emission bands and kinetics of emission and photoconduction in CdS in temperature region of quenching of luminescence. V. A. ARKHANGEL'SKAYA. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 2, 233–5 (1955) In Russian.

An investigation of growth and decay of luminescence in the red and infrared, and of photocurrents. Spectra at 20, 60 and 100°C show gradual development of longer waves up to 10 140 Å with rising temperature, but above 200°C the infrared emission disappears. The existence of two bands in phosphorescence is shown by two decay curves. Infrared luminescence is not due to impurities. The dependence of instantaneous emission on exciting light is not linear but proportional to 1·5 power. Agreement between growth and decay of phosphorescence and of photocurrent indicates emission due to recombination of electrons with centre. J. EWLES

535.371 : 539.23

6940. Transparent phosphor coatings. F. J. STUDER AND D. A. CUSANO. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 493–7 (*July*, 1955).

Transparent coatings of a number of luminescent materials have been deposited on glass surfaces by chemical reaction of the components in the vapour state. The best of these so far obtained is zinc sulphide. Arsenic, copper, manganese, phosphorus or zinc have been successfully introduced as activators. Under cathode-ray excitation some of these have given brightness as high as 40 foot-lamberts at 20 kV and 1 μA per cm^2. The u.v. response of these films is low, but varies with the conditions of preparation. The properties of these non-scattering phosphor screens are described and their advantages over powder phosphors considered. A.

535.371 : 548.7

6941. Current problems in crystalline luminescence. I. Introduction. M. CURIE AND D. CURIE. *Cahiers de Phys.*, *No.* 55, 1–36 (*March*, 1955) In French.

A discussion and review of inorganic phosphors, divided into four sections: (i) Structure of luminescent sulphides; application of energy-band model, structure of luminescence centres—theories of Williams; electron trapping processes and phosphorescence and thermoluminescence, stimulation; "killer" centres, surface states and excitons. (ii) Movement of electrons and holes in the crystal lattice; relation between luminescence and photoconduction, apparent bimolecular and monomolecular kinetics for conduction electrons; mobility of holes in sulphides, energy transfer by hole migration. (iii) Non-radiative transitions; importance in understanding luminescence processes. (iv) Cathodoluminescence.

G. F. J. GARLICK

535.371 : 548.7

6942. Current problems in crystalline luminescence. II. Displacement of electrons and holes in the crystal lattice. M. CURIE AND D. CURIE. *Cahiers de Phys.*, *No.* 56, 29–48 (*April*, 1955) In French.

Further treatment of luminescence mechanisms is given, especially the relations between luminescence and photoconductivity with and without infrared stimulation, and the effect of trapping states on the order of the processes, i.e. mono- or bi-molecular. The various methods of energy transport between centres such as positive-hole motion and wave-mechanical resonance are also discussed.

G. F. J. GARLICK

535.372

6943. Excitation spectra of silver activated alkali halide phosphors. R. ONAKA. *Science of Light* [*Tokyo*] **3**, *No.* 2, 156–63 (*March*, 1955).

The excitation spectra of silver-activated alkali halide phosphors in the region from 1 000 Å to 2 400 Å were measured. Since NaCl : Ag and NaBr : Ag phosphors respectively have two separate fluorescent emission bands of comparable intensity, the excitation spectra were measured separately for each emission band. From the experimental results obtained it has been found that the silver-activated alkali halide phosphors measured can be excited by far ultraviolet light. The excitation spectrum of NaCl : Ag phosphor has a fairly complex structure, and some of the wavelengths of the peaks agree with those of the absorption bands already reported. The excitation spectra of several silver-activated alkali halide phosphors were measured, but the analysis of the results was not successful. However, it is clear that the measurement of the excitation spectra should be a most useful method for the investigation of these phosphors. A.

535.375.5 : 539.133

6944. Intensity in the Raman effect. III. The effect of deuterium substitution on the intensity of Raman bands of benzene. G. ALLEN AND H. J. BERNSTEIN. *Canad. J. Chem.*, **33**, *No.* 6, 1137–44 (*June*, 1955).

For Pt I, see Abstr. 4557 (1955). Standard intensities of the Raman bands of C_6H_6, 1, 3, 5-$C_6H_3D_3$ and C_6D_6 have been obtained photoelectrically. An ambiguity in the vibrational assignment for 1, 3, 5-$C_6D_3H_3$ has been removed, and the assumption of the invariance of the polarizability and anisotropy derivatives upon isotopic substitution has been tested. A sum rule for depolarization ratios of Raman bands in isotopic homologues has been derived subject to the same assumptions used for obtaining the intensity sum rules. A.

535.375.54

6945. Raman spectrum of crystalline cadmium sulphate. T. S. KRISHNAN AND P. S. NARAYANAN. *Proc. Indian Acad. Sci. A*, **41**, *No.* 4, 121–4 (*April*, 1955).

A single crystal of $3CdSO_4 . 8H_2O$ has been investigated using the resonance radiation of mercury as exciter. The recorded spectrum reveals 23 Raman lines and of these 8 have been attributed to the internal oscillations of the SO_4 ion and 2 to the oscillations of the water molecules. While the number of translatory type of lattice oscillations permitted by the selection rules is 36, only 13 are observed experimentally. A tentative assignment for some of these vibrations has been made from a study of the variation of intensity of the lines with orientation. A.

535.376

6946. Luminescence of fused quartz under the action of ionizing radiations. M. LAUTOUT. *J. Chim. phys.*, **52**, *No.* 2, 169–75 (*Feb.*, 1955) In French.

Fused or crystalline quartz shows phosphorescence of long duration under X-ray, γ-ray or α-particle irradiation. For fused quartz the intensity of emission is much greater than for crystalline quartz.

G. F. J. GARLICK

535.376

6947. Absorption spectra and thermoluminescence curve of fused quartz irradiated by X-rays or γ-rays. M. LAUTOUT. *J. Chim. phys.*, **52**, *No.* 3, 259–66 (*March*, 1955) In French.

Absorption spectra show maxima at 5 500, 3 700, 3 000, 2 600 and 2 200 Å. An attempt is made to relate the spectra to the maxima in the thermoluminescence characteristics. G. F. J. GARLICK

535.376

6948. Photostimulation and coloration of fused quartz irradiated by X-rays or γ-rays. M. LAUTOUT. *J. Chim. phys.*, **52**, *No.* 3, 267–71 (*March*, 1955) In French.

X-ray or γ-ray irradiation sensitizes fused quartz

for excitation of luminescence under visible or ultraviolet radiation. In addition the high-energy irradiation causes a coloration change which appears as striations, giving an appearance like a turbulent liquid. See also preceding abstract. G. F. J. GARLICK

535.376

6949. A possible interpretation of the scintillation effect in crystal detectors. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 17, 1695–7 (*April* 25, 1955) In French.

535.376

6950. Voltage dependence of electroluminescent brightness. I. Dielectric embedded phosphors. F. A. SCHWERTZ, J. J. MAZENKO AND E. R. MICHALIK. Letter in *Phys. Rev.*, **98,** *No.* 4, 1133–4 (*May* 15, 1955).

For seven different ZnS phosphors embedded in plasticized polyvinyl chloride the brightness-voltage relation follows accurately the theoretical equation of Alfrey and Taylor for single crystals [contribution to discussion on paper reported in Abstr. 3605 (1955)]. The brightness is proportional to frequency and is determined by the number of optically active luminescence centres. G. F. J. GARLICK

535.376

6951. Voltage dependence of electroluminescent brightness. II. Chemically deposited phosphor films. F. A. SCHWERTZ AND R. E. FREUND. Letter in *Phys. Rev.*, **98,** *No.* 4, 1134 (*May* 15, 1955).

A ZnS–Mn film deposited by the method of Studer, Cusano and Young [see Abstr. 7765 (1951)] conforms to the Alfrey–Taylor equation relating brightness to applied voltage (see preceding abstract). It appears that any electroluminescent ZnS phosphor follows the law independent of its form, i.e. microcrystalline powder, evaporated layer or single crystal.

G. F. J. GARLICK

535.376 : 537.311.33

6952. Electroluminescence. A. FISCHER. *Z. angew. Phys.*, **7,** *No.* 5, 258–63 (1955) In German.

A review of published work on electroluminescence due to electron–hole recombination at *p–n* junctions in Ge and SiC and electroluminescence of ZnS phosphors produced by high applied electric fields. Up-to-date references are included. G. F. J. GARLICK

535.376 : 537.311.33 : 539.11

6953. Theory of electroluminescence. W. W. PIPER AND F. E. WILLIAMS. *Phys. Rev.*, **98,** *No.* 6, 1809–13 (*June* 15, 1955).

The theoretical basis for exciting luminescence by the application of an electric potential to a crystalline dielectric or semiconductor is considered. Three mechanisms of excitation are each shown to be theoretically feasible in appropriate solids and with suitable local field conditions: (1) the ionization of impurity systems directly by an electric field, (2) the acceleration of conduction electrons or positive holes in the valence band to kinetic energies sufficient to excite or ionize impurity systems or valence electrons by inelastic collisions, and (3) injection of charge carriers. Radiative de-excitation is feasible by two mechanisms: (*a*) direct recombination of conduction electrons and holes in the valence band, and (*b*) optical transitions characteristic of impurity systems known as activators. The characteristics of electroluminescence proceeding by these processes are examined theoretically. A.

535.376 : 537.542

6954. Yield of luminescence in organic scintillators. I. M. ROZMAN. Letter in *Zh. éksper. teor. Fiz.*, **28,** *No.* 2, 251–2 (1955) In Russian.

No satisfactory explanation has hitherto been given of the high yield of organic systems under excitation by slow electrons, α-particles or other slow charged particles. Experiments were carried out on the temperature effect on the yield of plastic scintillators made by polymerizing 1½% solution 1, 1, 4, 4, tetraphenyl-1, 3, 6 butadiene in purified sterol without catalyser at high temperature and pressure. These were excited by γ-rays of Co^{60}, and α-particles of Po. Results differ considerably from published data, especially in regard to initial increase of intensity at temperatures below −120°C. This initial increase is attributed to phosphorescence. Decay of this phosphorescence is shown for three temperatures and is not exponential. Thermoluminescence obtained by quick heating is, like the phosphorescence, very different for excitation by α- and γ-rays. For α-excitation decrease of yield of instantaneous emission occurs at a much lower temperature than under γ-excitation but the intensity of afterglow is much less. The thermoluminescence under α-excitation is very small, especially when it is considered that the energy absorbed by the scintillator exceeds that of γ-absorption by 10 times. It is possible that the difference is due to local heating by α-rays. J. EWLES

535.376 : 539.132

6955. Cathodo-luminescence spectrum and energy levels in MgO. B. D. SAKSENA AND L. M. PANT. Letter in *J. chem. Phys.*, **23,** *No.* 5, 989–90 (*May*, 1955).

535.39 : 539.23

6956. Graphical study of the optical properties of thin films of lightly absorbing material with index of refraction less than that of the support. D. MALÉ. *Rev. Opt.*, **34,** *No.* 5, 281–7 (*May*, 1955) In French.

The effect of variation of thickness on the reflecting coefficient and transmission coefficient of slightly absorbing thin layers is studied, using graphical methods. Curves are given for a variety of refractive index values. Phase changes on reflection are computed. The possibility of the existence of phase changes of 2π are shown when the refractive index and the thickness of the layer are simultaneously varied. Such phase jumps occur only for films which are of sufficient thickness and are not found for thin films with thickness less than 20 mμ. S. TOLANSKY

535.39 : 548.736.6

The structure and optical behaviour of jadeite. *See Abstr.* 7539

535.39 : 612.79

6957. Spectral reflectance of human skin in the region 235–1000mμ. J. A. JACQUEZ AND H. F. KUPPENHEIM. *J. appl. Physiol.*, **7,** *No.* 5, 523–8 (*March*, 1955).

A Beckman DU spectrophotometer modified with a substitution type integrating sphere was used for reflectance measurements of living human skin. The absorption bands of haemoglobin and water show up strongly. In the region 235–320 mμ the reflectance is

low, and the curves are nearly identical for different individuals. This can be ascribed to scattering and reflection from the topmost layers. The contribution of skin fluorescence to the measured reflectance has been investigated by the use of cut-off filters to eliminate the wavelengths used to excite the fluorescence. Above 300 mμ the contribution of the fluorescence is negligible; below 300 mμ it is small in absolute value although it may represent 10–20% of the low reflectance measured in the ultraviolet. A.

535.417 : 531.717 : 539.23

6958. Simple interference prisms for the evaluation of the thickness of thin films. G. C. MÖNCH. *Optik*, **12**, *No.* 5, 226–32 (1955) In German.

A variety of prism interferometric arrangements is described using in each case right-angled prisms. The systems are somewhat related but different from that of the Kösters double prism. The prism mounts are described in detail and illustrated schematically. Application of the interferometric system to the measurement of thin films is considered and an example quoted. S. TOLANSKY

535.417 : 535.345.6

6959. Improved methods for producing interference filters. P. H. LISSBERGER AND J. RING. *Optica Acta*, **2**, *No.* 1, 42–6 (*April*, 1955).

The production of all-dielectric interference filters necessitates an accurate method of controlling layer thickness. A technique is described which is a modification of that due to Giacomo and Jacquinot, and which enables such filters to be constructed without the use of control surfaces. With this method the position of a filter pass-band may be located to within ± 20 Å. The useful area of a filter is limited by the non-uniform thickness of evaporated layers. Results are given of the increase in this area made possible by rotating the glass substrate during deposition. A.

535.417 : 535.42

6960. Interferometric methods for the study of diffraction images. H. H. HOPKINS. *Optica Acta*, **2**, *No.* 1, 23–9 (*April*, 1955).

The photometric difficulties which are presented in direct measurements are discussed and it is shown that a wavefront-shearing and a wavefront-tilting interferometer may be used to study respectively the transmission factors and point source diffraction images for any optical system. A.

535.42

6961. Optical images of linear gratings. A. NARATH AND G. SCHIMMEL. *Optik*, **12**, *No.* 5, 206–14 (1955) In German.

Formulae are derived from diffraction theory for the maximum and minimum intensities in the image of a self-luminous grating. The effect of the relative aperture and the grating constants on these intensities and the contrast is then deduced. Similar formulae are obtained for the distribution when the grating has a finite number of lines. Examples of the use of the formulae are included. R. W. FISH

535.421

6962. Ruling of a curved grating. Y. SAKAYANAGI. *Science of Light* [*Tokyo*] **3**, *No.* 2, 79–83 (*March*, 1955).

According to the author's recent theory [Abstr. 1738 (1955)] the curved grating has the peculiarity that stigmatic points appear on the Rowland circle for particular angles of incidence and diffraction. In the present paper a method of actually ruling this curved grating and results of its use are described. A.

535.421 : 538.566

6963. On the diffraction of a plane wave by an infinite plane grating. G. L. BALDWIN AND A. E. HEINS. *Math. Scand.*, **2**, 103–18 (1954).

A monochromatic electromagnetic wave of arbitrary polarization is incident normally on a grating, which consists of an infinite set of parallel strips. The amplitude, phase and direction of propagation of the transmitted and reflected waves at a great distance are found. An integral equation method is used, the solution being obtained by the Wiener–Hopf technique. MATHEMATICAL REVIEWS

535.43

6964. Study of light scattering by monoammonium phosphate. L. TAUREL AND J. CHAPELLE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1985–7 (*May* 16, 1955) In French.

Experimental results are given and compared with theoretical values. Possible reasons for the anomalies are given. [See Abstr. 4429 (1954); 1740 (1955).] H. G. JERRARD

535.43

6965. Scattering of light by an air bubble in water. G. E. DAVIS. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 572–81 (*July*, 1955).

The angular distribution of intensity of light scattered from a collimated beam incident upon a spherical air bubble in water is determined for any bubble with radius greater than a few wavelengths of the incident light. The computations are for wavelength 5 893 Å and $n = 1{\cdot}3334$, the relative index of refraction of water at 15°c. One external reflection, five internal reflections and six refractions are considered. A general equation for the geometric attenuation factor is developed, with special forms for external reflection and for zero angle of incidence. The limits of accuracy of the equations for angles of scattering in the neighbourhood of 0° and 180° are evaluated. The effects of diffraction and interference are assumed to be negligible. The fractions of the incident light scattered from each of the six "surfaces" (successive points of incidence of any ray on the spherical surface) are shown by accurate curves for all angles of deviation. The corresponding geometric attenuation factors are similarly shown. Final intensity values are tabulated and are plotted both with rectangular and with polar co-ordinates. A.

535.435/.436

6966. Reflection correction to measurements of the molecular scattering of light. P. PUTZEYS AND J. MINET. *Ann. Soc. Sci. Bruxelles I*, **69**, *No.* 1, 29–36 (1955) In French.

Formulae are developed for correction for the reflections at the outer and inner faces of the glass container for the specimen. But because of the uncertainty of the value for the glass-air reflection it is concluded that it is more reliable to immerse the cell in a liquid. G. F. LOTHIAN

535.51 : 535.43

6967. On the dependence of the depolarization factor [ρ] of light scattered from dielectric spheres on the direction of the vibration plane of the incident light. J. Moser. *Annu. Fac. Phil. Skopje Sect. Sci. nat.*, **1953,** *Paper* 3, 11 *pp.* In Serbo-Croatian with summary in German (1 *p.*).

The known theoretical relations between the ρ values for light plane-polarized at various angles to the scattering plane are confirmed for scatter from a colloidal solution. Unfiltered sunlight is passed through a polaroid to the solution cell; light scattered at 90° enters a Wollaston prism and the intensities of the 2 beams are matched visually by an adjustable Nicol. G. F. LOTHIAN

535.515 : 535.317.3

6968. Achromatic combinations of birefringent plates. I. An achromatic circular polarizer. S. Pancharatnam. *Proc. Indian Acad. Sci. A*, **41,** *No.* 4, 130–6 (*April*, 1955).

Circularly polarized light is obtained by superposing two half-wave plates and one quarter-wave plate, all of the same material, such that the fast vibration-directions of the successive plates make specific angles θ_1, θ_2, θ_3 with the azimuth of the linear vibration incident on the first plate. The required range of achromatism determines the optimum values of the angles. Thus, using mica retardation plates prepared for Na 5890, the range from 4000 Å to 7800 Å is covered with $\theta_1 = 6° 52'$, $\theta_2 = 34° 32'$, $\theta_3 = 100° 20'$; while the range 4400 Å to 7400 Å can be covered with superior achromatism by taking $\theta_1 = 6° 30'$, $\theta_2 = 34° 34'$, $\theta_3 = 101° 8'$. A.

535.515 : 535.317.3

6969. Achromatic combinations of birefringent plates. II. An achromatic quarter-wave plate. S. Pancharatnam. *Proc. Indian Acad. Sci. A*, **41,** *No.* 4, 137–44 (*April*, 1955).

An achromatic quarter-wave plate is obtained by superposing three birefringent plates of the same material; the first and last should have the same retardation $2\delta_1$, their fast vibration directions being parallel to one another but inclined at a specific angle c to that of the central plate—of retardation π. The desired range of achromatism determines the optimum values of $2\delta_1$ and c (which, in turn, will determine the orientation of the effective principal planes of the combination). As an example, using mica retardation plates prepared for Hg 5461, the range from 4100 Å to 6800 Å is covered with $2\delta_1 = 115° 42'$ and $c = 69° 54'$. Further, for a particular wavelength, a birefringent compensator of variable retardation (0 to 2π) is obtained by interposing a half-wave plate that can be rotated in its own plane, between two quarter-wave plates that have their fast vibration directions parallel. The results follow from the Poincaré sphere by geometrically compounding successive rotations. A.

535.55

6970. Mechanical birefringence of a polyester. B. Persoz and J. Bonnet. *J. Chim. phys.*, **52,** *No.* 2, 157–61 (*Feb.*, 1955) In French.

Test specimens consisting of sheets 1 to 3 mm thick of an American polyester resin, Laminac 4116 (a phtalomaleate of propylene glycol copolymerized with styrene) have been submitted to a constant elongation for 30 minutes and then released. The variation of birefringence, measured by the Tardy method, is found as a function of time and temperature. Five birefringence-time curves for 60 minutes duration are shown at temperatures of 31°C, 50°C, 60°C, 85°C and 154°C. At 31°C, the birefringence decreases from a positive value. At 50°C it changes from a positive value to a negative one on release of the stress. At 60°C the same change occurs before the release. At 85°C the initial birefringence is negative and changes to zero. At 154°C the negative birefringence changes to a positive value on release of the stress and remains positive. Other curves are given and the results discussed. It is suggested that they may be explained by assuming two phases to exist, one of which has a negative photoelastic coefficient. See Abstr. 4439 (1954). H. G. JERRARD

535.55

6971. On the application of the theory of errors to the solution of a system of equations used in photoelasticity. H. Favre. *Rev. Opt.*, **34,** *No.* 6, 305–22 (*June*, 1955) In French.

Applying purely optical methods in photoelasticity a system of relations is obtained, the number of equations being greater than the number of unknowns. It is shown in this paper how to apply the method of least squares of Gauss to solve this system in the case of two dimensional elasticity and in the case of bent plates. The values obtained for the stresses and the bending moments together with their accidental errors are discussed and a number of conclusions established. A.

535.55 : 536.42

Study of the second-order transition temperature of high polymers by the photoelastic method. *See Abstr.* 6983

535.55 : 666.1.056.5

6972. Optical stress measurements on glass-metal seals at high temperatures. H. Herrmann. *Z. angew. Phys.*, 7, *No.* 4, 174–6 (1955) In German.

Details are given of a small oven which has been built for such measurements. It is used in combination with a polarization microscope to examine the seals up to the annealing temperature of the glass. The method used is described and some results are presented. The advantage of the use of a small oven is discussed. H. G. JERRARD

535.653 : 774/777

6973. Color correction process. P. E. Tobias. *J. Opt. Soc. Amer.*, **45,** *No.* 7, 535–8 (*July*, 1955).

A method of colour correction has been developed based upon the observation that any colour within the gamut of the four-colour process printing inks can be reproduced by pairs of the chromatic inks plus black. The chromaticity co-ordinates of a colour will vary with the two chromatic ink mixtures, whereas the luminance is controlled by the amount of black used. A device is developed in which the empirical relationship existing between the chromaticity of a given copy and the amounts of each of the chromatic inks required for match is readily employed. The luminance of the copy is then matched by addition of

black. Inherently this process has the advantage of basic simplicity, allowing empirical compromises or corrections for distortion. A.

535.7

Physiological optics. Vision. *See under* "Medical science. Human physiology." Decimal classification 612.84

535.81

6974. Homogeneity defects in vitreous silica. V. GARINO-CANINA. *Rev. Opt.*, **34**, *No.* 6, 323–33 (*June*, 1955) In French.

Homogeneity defects are studied by two different methods: the Françon birefractive interferometer, and the method of multiple wave interferences. The local variations of refractive index are about 10^{-5} in usual quality silica. This material cannot be used for precision optics. With a special melting process, it is possible to obtain "homogenized" silica which has refractive index variations only 10^{-6}, which is suitable in most cases. A.

535.822.9

6975. A new arrangement for fluorescent microscopy in transmitted and reflected light. A. KRIEG. *Z. wiss. Mikr.*, **62**, *No.* 4, 256–64 (*March*, 1955) In German.

The use of the Zeiss–Winkel fluorescence microscope is described. Details of the illumination system, the transmission curves of the filters, and the performance are given. R. W. FISH

535.822.9

6976. Multiple images in reflecting microscopes. W. H. STEEL. Letter in *Austral. J. Phys.*, **8**, *No.* 1, 186–90 (*March*, 1955).

The normal image of a reflecting microscope is formed by a single reflection at each mirror surface. Secondary images are possible by two or more reflections at each mirror surface. With central obscuration of the pupil, this secondary light does not reach the axial image point, but it may reach the outer parts of the field, reducing contrast. Methods of choosing stop positions to eliminate the secondary images are discussed in detail. R. W. FISH

535.823.5 : 778.34

Stage noise and spurious scattering. *See Abstr.* 7610

535.833

6977. The field of view and image brightness in telescopes. C. V. HOFE. *Optik*, **12**, *No.* 5, 201–5 (1955) In German.

The simple geometric relationships between lens parameters, focal length and diameter, and the field of view and exit pupil diameter are derived for the basic Galilean and Kepler telescopes. A comparision of the two types is made. R. W. FISH

535.89 : 545.82

6978. Investigations on light sources for spectrochemical analysis. VIII. A thyratron-controlled interrupted arc source. Á. BARDÓCZ. *Acta tech. Hungar.* **11**, *No.* 1–2, 65–84 (1955) In German.

For Pt V, see Abstr. 10113 (1954). The system consists of an arc circuit, an ignitor circuit and a pulse generating circuit. The arc circuit is built up of conventional circuit elements. In the ignitor circuit the condenser energy necessary to ignite the arcs is controlled by a thyratron tube. The ignitor circuit allows the igniting energy to pass through the thyratron tube, without, however, overloading it and is a.c. or d.c. operated according to the required number of ignitions, 50 and 100 per second respectively, at the maximum rate. The thyratron tubes of the ignitor circuits are controlled by pulse generators of variable frequency, delivering, at the maximum, 50 or 100 control signals per second. A critical survey of various electronically controlled ignitor circuits is given. A.

535.89 : 621.327.3 : 621.373.42

6979. A simple 500 Mc/s oscillator for use with electrodeless mercury-198 lamps. A. THULIN. *J. sci. Instrum.*, **32**, *No.* 7, 257–8 (*July*, 1955).

The oscillator, simply adjustable in frequency from 300 to 500 Mc/s, consists of a parallel line resonator associated with a double triode developed for mobile transmitters. It is intended for the excitation of electrodeless mercury-198 lamps for use in interferometry. A.

HEAT 536

536.2 : 532.13

Heat conductivity–viscosity relationship for liquids. *See Abstr.* 6783

536.21

6980. New results on the temperature distribution in a boiler water-pipe at very high pressures. M. A. STŸRIKOVICH AND M. E. SHITSMAN. *Dokl. Akad. Nauk SSSR*, **96**, *No.* 1, 69–72 (1954) In Russian.

Experiments were performed on a short section of thick-walled pipe (internal diameter 30 mm), with suitable end corrections. It was found that the normal temperature distribution on the wall of a vertical pipe at very high pressures is seriously disturbed for steam contents considerably less than unity and specific thermal fluxes less than 700 000 kcal/m²hr. The permissible steam content to ensure a normal temperature distribution was found as a function of the pressure, the steam velocity and the thermal flux; graphs are given to show this function. The pressures used range from 182 to 209 kg/cm², the specific thermal fluxes from 230 000 to 720 000 kcal/m²hr, the circulation rates from 0·2 to 2·2 m/sec, the velocities of the steam (by weight) from 60 to 400 kg/m²sec, and the steam contents from 8% to 100%. J. B. SYKES

536.212.3

6981. Lattice thermal conductivity. J. S. DUGDALE AND D. K. C. MACDONALD. *Phys. Rev.*, **98**, *No.* 6, 1751–2 (*June* 15, 1955).

Consideration of the anharmonic properties of a linear chain suggests that the dimensionless quantity $\alpha\gamma T$ is in general a measure of the anharmonicity of a lattice (α is the thermal expansion coefficient and γ the Grüneisen parameter). It is therefore proposed that the mean free path for lattice vibrations in an insulator should, in the classical temperature region, be approximately $A_0/\alpha\gamma T$, where A_0 is the lattice spacing. Reasonably good agreement with experiment is found. A.

536.24

6982. Investigation of heat exchange in the boiling of a liquid in pipes. L. S. STERMAN. *Zh. tekh. Fiz.*, **24**, *No.* 11, 2046–53 (1954) In Russian.

Experiments were performed on this subject in order to relate the heat exchange to various criteria depending on the circulation rate, the thermal flux and, to some extent, the vapour content; the range examined, however, was that where the vapour content has no noticeable effect. The results were combined with those of the author and of other workers, for both water and ethyl alcohol, and graphs are given showing the interrelation of the values found; these lie on a common curve representing a certain function of the criteria concerned. The pressures used range from 2 atmospheres to 52 atmospheres, the circulation rates from 0·2 to 6·67 m/sec, and the thermal fluxes from 22 000 to 1 000 000 kcal/m²hr. Although the results are valid only for the case of low vapour contents, a number of situations are pointed out in which they can be applied to calculate the heat exchange. J. B. SYKES

536.42 : 535.55

6983. Study of the second order transition temperature of high polymer by the photoelastic method. M. KANEKO, R. MURAI, K. KISHI AND D. MORI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 1, 78–9 (*Jan.*, 1955).

The birefringence produced in strips of polystyrene and polyvinyl chloride (P.V.C.) when subjected to tension is measured as the temperature changes. A Szivessy–Dierkesmann compensator is used. Graphs of birefringence against temperature are plotted for the temperature range 40–120°C for polystyrene under 150 g.cm^{-2} tension and for P.V.C. under 200 g.cm^{-2} tension. In both cases as the temperature increases the birefringence is first constant at a small value, then increases rapidly, then decreases and finally increases again. These four divisions appear to correspond to a solid-like region, a transition region, a rubber-like region and a flow region respectively. The transition point at the inflection point of the second region is 95°C for polystyrene and 70°C for P.V.C. H. G. JERRARD

536.421.4

6984. On ice formation in pure supercooled water. W. JACOBI. *Z. Naturforsch.*, **10a**, *No.* 4, 322–30 (1955) In German.

The dependence of the degree of supercooling on the drop diameter has been investigated. The observed maximum, viz. −37°C for 10 μ radius, can be quantitatively explained by Volmer's nucleation theory. The interfacial energy between ice and water can be deduced and is in agreement with other estimates of this quantity. L. G. CARPENTER

536.44

6985. Some anomalies in the data on coexistent densities in the region of the critical temperature. S. W. BENSON AND C. S. COPELAND. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1180–1 (*June*, 1955).

The critical volume is usually found by using the law of rectilinear densities and extrapolating the average of the co-existent densities to the critical temperature. It is shown that near the critical point the data are consistent with a law of rectilinear volumes and a similar extrapolation yields critical volumes some 4% lower than the values usually obtained. R. O. DAVIES

536.46 : 534.413 : 534.142.4

On the stability of a plane flame front in oscillating flow. *See Abstr.* 6817

536.48

6986. Effect of a centrifugal field upon the rate of transfer through a helium II film. J. W. BEAMS. Letter in *Phys. Rev.*, **98**, *No.* 4, 1138 (*May* 15, 1955).

A helium film is formed on bundles of thin wires packed into metal tubes and fixed on the rotor of a centrifuge in radial direction; the temperature of the rotor is held below the λ-point of helium. Liquid helium is supplied at the boundary of the rotor and the pressure at its centre can be measured. If the rotor is set in motion the pressure at the centre drops, indicating that the outward flow of vapour is not fully compensated by film flow of liquid in inward direction The result is interpreted as showing a retardation of the rate of film transfer by the centrifugal field. When rotation is in progress the pressure at the centre begins to rise again; this effect is presumably due to frictional heating of the rotor. R. EISENSCHITZ

536.48 : 536.7

6987. Thermodynamic properties of liquid helium three. I. The specific heat and entropy. T. R. ROBERTS AND S. G. SYDORIAK. *Phys. Rev.*, **98**, *No.* 6, 1672–8 (*June* 15, 1955).

Specific heats of saturated liquid He^3 have been measured between 0·37° and 2·36°K. The data fit the empirical equation, $C = 0{\cdot}577 + 0{\cdot}388T + 0{\cdot}061\,37T^3$ (cal/mole deg), to about $\pm 1{\cdot}0\%$ between 0·5° and 1·7°K. The standard deviations of most of the individual points are between 1 and 2%. Entropy differences are calculated from the above equation and combined with a value of entropy of 1·44 cal mole^{-1} deg^{-1} at 0·5°K to give the total entropies. The difference between the total entropy and the entropy of nuclear spin disorder is remarkably linear with and nearly proportional to T. The present and earlier warmup experiments give no indication of existence of a specific heat anomaly in liquid He^3 between 3·21° and 0·37°K. The present work also shows that a λ transition comparable to that occurring in liquid He^4 will not be found in liquid He^3 at any temperature below 0·37°K. A.

536.48

6988. Extinction of second sound in helium II. K. N. ZINOV'EVA. *Zh. éksper. teor. Fiz.*, **25**, *No.* 2(8) 235–47 (1953) In Russian.

At the end of a cylindrical tube waves of second sound are transmitted by a heater and received at the other end by a resistance thermometer. Apparatus is similar to that used in previous work [Abstr. 3949 (1949)] apart from a new amplifier by means of which fluctuations down to 10^{-7} V can be observed. Experiments are made with standing waves, in particular by measuring the width of resonance peaks from which the extinction coefficient is derived. In preliminary runs the independence of this coefficient from the amplitude is checked. It is found that results become irregular if the frequency is too high; the author assumes that in this case transversal waves could be

excited, and restricts frequencies to the range of 20–2 500 sec^{-1}. Also leakages in the tube may cause irregularities on account of eddies being formed. Measurements are made at temperatures between 1·0 and 2·1°K. It is found that the width of the resonance peaks ($\Delta\nu$) is broadly proportional to the square root of the frequency (ν). Examining the results in a more elaborate way $\Delta\nu/\nu^{\frac{1}{2}}$ is plotted against $\nu^{3/2}$. Measurements can be interpolated by rectilinear graphs which do not tend to the origin. By means of these graphs two different contributions to the process of absorption of second sound are separated, a surface effect and extinction in the bulk of the liquid. On theoretical grounds the former is mainly due to viscosity and the latter to thermal conductivity. Results of measurements are accordingly used for calculating these properties of the liquid. Comparison with alternative values as derived from the two-fluid model reveals marked discrepancies. It is claimed that the existence of a discontinuity of temperature at the walls is established by correlating results of experiments with tubes of glass and of copper. R. EISENSCHITZ

536.48

6989. Superfluidity and heat transport in the unsaturated helium-II film. E. LONG AND L. MEYER. *Phys. Rev.*, **98**, *No.* 6, 1616–22 (*June* 15, 1955).

The mobility of unsaturated He-II films has been investigated by heat transport measurements as a function of thickness and temperature. The results confirm data from previous flow measurements that at a given temperature a certain number of layers are immobile, changing smoothly from ~2 at 1·3°K to ~10·5 at 2·0°K. All additional layers flow in a temperature gradient with about the same drift velocity, this velocity being of the same order of magnitude as that derived from the transfer rate of the saturated film. Films of thickness between 20–80 layers show superfluidity at and even slightly above the λ temperature of the bulk liquid. A.

536.51

6990. Measurement of the surface temperature of glass heated by radiation. H.-J. HÜBNER. *Z. angew. Phys.*, **7**, *No.* 6, 273–9 (1955) In German.

The surface temperature of the glass envelope of burning electric lamps is of importance in connection with explosion hazards. Methods of measuring this temperature are compared. First the reflection coefficient of the glass to radiation from a black body at known temperature is determined for a wavelength of 7·76μ and the glass temperature is calculated therefrom. Other methods are the use of solids of known melting point and of thermocouple wires around the glass bulb. It is concluded that provided certain conditions are fulfilled these last two methods give results which are good enough for all practical purposes.

E. H. DOCK

536.52

6991. A small pneumatic pyrometer. A. M. GODRIDGE, R. JACKSON AND G. G. THURLOW. *J. sci. Instrum.*, **32**, *No.* 7, 279–82 (*July*, 1955).

The theory of the pneumatic pyrometer, in which gas temperature is determined from density measurements, is outlined and the design and characteristics of a small instrument are reported. Calibration curves covering a wide temperature range (200 to 1 550°C) are given and the use of the instrument is described. A.

536.521

6992. The influence of ambient temperature on the readings from optical pyrometers with disappearing filaments. G. URBAIN. *Rev. Opt.*, **34**, *No.* 4, 193–203 (*April*, 1955) In French.

Tests carried out on five commercial optical pyrometers show that there is a marked difference in behaviour with changes in ambient temperature. The lamp itself is shown to be largely responsible for these effects. Means of overcoming the disadvantages are considered and the regulation of the ambient temperature to ±2°C is recommended. R. W. FISH

536.531 : 551.23

A field instrument for measuring temperatures of natural boiling pools. *See Abstr.* 7550

536.62

6993. Experimental standardization of the Calvet microcalorimeter. G. LAVILLE. *C.R. Acad. Sci. [Paris]* **240**, *No.* 11, 1195–7 (*March* 14, 1955) In French.

Following a general examination of the theory of this calorimeter [Abstr. 5377 (1955)] the author now considers the determination of the calorimeter constants by an electrical heating method. F. E. HOARE

536.62 : 536.631

6994. The measurement of lattice specific heats at low temperatures using a heat switch. F. J. WEBB AND J. WILKS. *Proc. Roy. Soc. A*, **230**, 549–59 (*July* 12, 1955).

The accuracy of the measurement of small specific heats at low temperatures is often limited by the difficulty of achieving adequate thermal insulation of the specimen, especially when exchange gas has been used to cool it down. The paper describes a make-and-break contact which makes possible a degree of thermal insulation an order of magnitude higher than is usually obtained. This "heat switch" has been used to measure the specific heats of three substances with a simple lattice structure. It has been verified that the temperature variation of the specific heats of potassium chloride and grey tin is very close to a T^3 relation at temperatures below about $\theta_D/60$. The specific heat of graphite is more complex because of the anisotrophy of the lattice. A.

536.631

6995. Atomic heats of copper, silver, and gold from 1°K to 5°K. W. S. CORAK, M. P. GARFUNKEL, C. B. SATTERTHWAITE AND A. WEXLER. *Phys. Rev.*, **98**, *No.* 6, 1699–707 (*June* 15, 1955).

The atomic heats of copper, silver and gold have been determined in the temperature interval 1·0° to 5·0°K. The measured values can be described adequately by a linear plus a cubic term in temperature. Any deviations from this relationship are explainable in terms of inaccuracies in the presently accepted helium vapour pressure—temperature scale. In fact, it is shown that the temperature scale corrections, necessary to correct the data to the simple law given above, essentially agree with temperature scale corrections suggested by other work. Values of the coefficient of the linear term (electron heat capacity) and

the Debye characteristic temperature have been derived and compared with several indirect determinations, as well as with other calorimetric data, where possible. The values of the electronic heat capacity determined in the work are consistently lower than those from previous work on copper and silver. A.

536.631 : 539.31

6996. Vibration spectra and specific heats of cubic metals. II. Application to silver. A. B. Bhatia and G. K. Horton. *Phys. Rev.*, **98**, *No.* 6, 1715–21 (*June* 15, 1955).

The frequency spectrum of silver, and hence its specific heat C_v at constant volume as a function of temperature, are calculated by solving the secular equation derived in Pt I [Abstr. 3257 (1955)] for the determination of the frequencies of the normal modes of vibration of a monovalent face-centred cubic metal. The calculations are made with two sets of elastic constants, namely, with their values at abolute zero of temperature and at room temperature. The calculated C_v are compared with the experimental data and with the earlier calculations based on a two force-constant model (in contrast to the three appearing in the secular equation) by plotting the corresponding effective Debye temperatures Θ against temperature. It is found that, except for temperatures below about 7°K, the agreement between theory and experiment is satisfactory. It is shown that the discrepancy between the two sets of values below 7°K can be partly removed by making a choice for the elastic constants slightly different from that actually used in the calculation. However, it appears that the explanation of the entire discrepancy at low temperatures for silver and of a similar one found in Pt I for sodium lies elsewhere. A.

THERMODYNAMICS 536.7/.8

536.7 : 539.132

6997. High-speed machine computation of ideal gas thermodynamic functions. II. The diatomic free radicals of the isotopic hydrides of oxygen and sulfur. L. Haar and A. S. Friedman. *J. chem. Phys.*, **23**, *No.* 5, 869–75 (*May*, 1955).

For Pt I, see Abstr. 2977 (1955). The partition functions for the free radicals are obtained in closed form. They include terms to account for the special low-temperature effects arising with these molecules. The splitting of the $^2\pi$ ground state is complicated by the uncoupling of the electronic spin from the nuclear axis. In addition to this effect the partition function includes first-order corrections for rotation-vibration coupling, rotational stretching and vibrational anharmonicity. Tables of thermal functions are computed on the N.B.S. Eastern Automatic Computer—SEAC —from 50° to 5000°K for OH, OD, OT, SH, SD and ST. A.

536.75 : 535.23

6998. Entropy of radiation. A. Ore. *Phys. Rev.*, **98**, *No.* 4, 887–8 (*May* 15, 1955).

In view of the recent publication [Abstr 914 (1955)] of a derivation of the expression for the entropy flux of radiation, in terms of its spectral specific intensity, a brief comparative study of various known methods for obtaining the entropy formula is presented. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.223

6999. A belt generator with field equalization. W. Knauer. *Z. angew. Phys.*, **7**, *No.* 3, 118–26 (1955) In German.

An attempt is made to utilize space-charge development as a means of field equalization for an electrostatic belt generator. By using a covering envelope of thin "Perlon" plastic the 630 kV generator can be run at 1 500 kV without discharge. Introduction of CCl_4 into the envelope increases the possible working potential to 1 800 kV. Detailed analysis of field conditions is included. G. F. J. GARLICK

537.223 : 537.534

Electrostatic generator in compressed gas. *See Abstr.* 7129

537.226.08 : 539.133

7000. An apparatus for the determination of dipole moments. C. C. Meredith and G. F. Wright. *Canad. J. Technol.*, **33**, *No.* 3, 182–93 (*May*, 1955).

The machine described here will determine precisely the dielectric constant of either 15 ml of liquid or 0·5 g of solid. A.

537.226.1

7001. The correspondence between the stability of chemical compounds and their dielectric strength. A. A. Vorob'ev, E. K. Zavadovskaya and A. M. Trubitsin. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 6, 1065–6 (1955) In Russian.

A relation between dielectric strength of pure crystals of alkali-halide salts and the formation heat of the crystals is presented, and this is extended to the dielectric strength of monocrystals of isomorphous mixtures with substituted halide. In the latter case the dielectric strength decreases with increasing energy of formation of the solid solution, whereas in the case of alkali-halide monocrystals the dielectric strength increases with formation energy. ELECTRICAL RESEARCH ASSOCIATION

537.226.1 : 539.133

7002. The electric moments of polar gases and liquids. Yu. M. Volokobinskiĭ. *Dokl. Akad. Nauk SSSR*, **97**, *No.* 5, 813–16 (1954) In Russian.

In the absence of an external field magnitude and direction of the dipole moment $\overline{M}$ of a polar dielectric vary in such a way that the average value of the projection of the vector M on a given direction over a finite time interval is zero. However, the r.m.s. value of the dipole moment $\overline{M}^2$ and of its projection on a given direction do not vanish and may be accurately determined. The author presents a new method for this. ELECTRICAL RESEARCH ASSOCIATION

537.226.1.08

7003. Measurement of dielectric constants through the splitting of degenerate eigen-frequencies. M. SCHRÖDER. *Z. angew. Phys.*, **7**, *No.* 4, 169–74 (1955) In German.

The sample is placed in a microwave resonator with degenerate modes which are split by the asymmetric arrangement of the sample. The difference between the two resonant frequencies is related to ε and the difference of Q values to $\tan\delta$. Experimental details and examples of its use are given for a square cross-section resonator working at 9 000 Mc/s.

D. H. WHIFFEN

537.226.1.08 : 621.315.61 : 621.317.335.3

7004. Measurement of high permittivity dielectrics at microwave frequencies. F. E. HARRIS AND C. T. O'KONSKI. *Rev. sci. Instrum.*, **26**, *No.* 5, 482–5 (*May*, 1955).

Apparatus is described for measurement of the complex dielectric constant of liquids of high permittivity in the range from 1 to 10 cm wavelength. The method is chosen for sensitivity in the region of high permittivity and requires no moving parts or measurements within the sample. Transmission coefficients of samples contained between mica windows in short sections of waveguide are measured by mixing the wave transmitted through the sample with a wave of fixed amplitude and phase travelling in the opposite direction. The resulting standing wave pattern is detected with a travelling probe. Equations are given relating primary data with dielectric properties of the samples, and solutions are obtained by graphical means.

A.

537.226.1.08 : 621.315.615 : 621.317.335.3

7005. A simple and rapid method of measuring the complex permittivity of a liquid. E. H. GRANT. Letter in *Brit. J. appl. Phys.*, **6**, *No.* 5, 181 (*May*, 1955).

The complex permittivity of liquids of medium or high loss angle can be found from the positions of two points of equal amplitude in the standing-wave set up in a short-circuited coaxial line containing the liquid. The method has been used for water at 17 cm wavelength.

J. H. MASON

537.226.2

7006. Dielectric anomaly of ammonium sulfate at its transition temperature. K. KAMIYOSHI AND T. MIYAMOTO. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **7**, *No.* 1, 91–8 (*Feb.*, 1955).

Dielectric anomaly accompanied by a phase transition of the single crystal of ammonium sulphate was observed at audio and radio frequencies. It was found that a sharp peak appeared in the a-axial direction and kinks appeared in the b- and c-axial directions and that the transition temperature was −36°C on cooling and −29°C on warming. The dielectric constants at room temperature were determined to be 8·0, 7·45 and 6·7 along a-, b- and c-axial directions, respectively. They are independent of frequency between 10 to 10^5 kc/s. It was also found that the transition temperature of a pressed polycrystalline powder specimen was ~ -53°C, which was much lower than that of single crystal.

A.

537.226.2

7007. Dielectric constant and association of pyrrole. P. TUOMIKOSKI. Letter in *J. Phys. Radium*, **16**, *No.* 4, 347–8 (*April*, 1955) In French.

The dielectric constant was measured at temperatures from 19°C to 83°C. From these values the Onsager moment was calculated and a graph of μ e against $1/T$ showed a curve with downward slope (th- corresponding curve for phenol going steeply up ward). According to Kirkwood's theory this suggests that pyrrole associates with antiparallel dipoles, whilst phenol associates with parallel dipoles.

A. J. TAYLOR

537.226.2

7008. Influence of mechanical pressure on the dielectric characteristics of ferroelectric ceramics. E. V. SINYAKOV AND I. A. IZHAK. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 2, 243–6 (1955) In Russian.

Total and spontaneous polarization decrease with rising pressure; induced polarization is practically unaffected. The dielectric constant at h.f. in a weak field is also reduced by pressure, most of all at the Curie point, similar phenomena being observed at 50 c/s, even at a higher relative rate. Collateral (hydrostatic) pressure shifts the Curie point towards lower, unilateral pressure towards higher, temperatures, which had been predicted by the authors from thermodynamical considerations.

ELECTRICAL RESEARCH ASSOCIATION

537.226.2

7009. Ferroelectric characteristics of solid solutions of barium zirconate in barium titanate. G. A. SMOLENSKIĬ, N. P. TARUTIN AND N. P. GRUDTSIN. *Zh. tekh. Fiz.*, **24**, *No.* 9, 1584–93 (1954) In Russian.

In their ferroelectric characteristics, solid solutions of barium zirconate and barium stannate in barium titanate are analogous. The maximum permittivity is observed at a concentration of 18% barium zirconate. In the low-temperature range the shift of the Curie temperature is slower for the zirconate than for the stannate. The permittivity of solutions with small electrostriction is considerably reduced by high-voltage polarization.

ELECTRICAL RESEARCH ASSOCIATION

537.226.2

7010. On the dielectric properties and phase-changes in mixed-crystal systems of the perovskite type. O. JAKITS. *Dissert. E.T.H. Zürich, Paper* 2337, 43 *pp.* (1954) In German.

Mixed crystals of (*a*) $(KLa)_{0.5}TiO_3$–$BaTiO_3$, (*b*) $(KNd)_{0.5}TiO_3$–$BaTiO_3$, (*c*) $SrTiO_3$–$BaTiO_3$ and (*d*) $CaTiO_3$–$SrTiO_3$ were prepared and the following measurements on them are reported: lattice-constant against composition, dielectric constant against temperature for various compositions, transformation and ferroelectric Curie temperatures, spontaneous electric polarization, dielectric constant dependence on biasing field, phase-diagram boundaries. The results are interpreted according to the model of S. Roberts [Abstr. 2761 (1950)], but it is found that the polarizability of the Ti-ion varies steeply with its distance from the nearest O-ion neighbour.

F. F. ROBERTS

537.226.2 : 548.736.5

7011. Dielectric characteristics and structure of polycrystals of the system $ZnO.TiO_2$–$1 \cdot 5MgO.TiO_2$. G. I. Skanavi and V. V. Maslov. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 735–41 (1954) In Russian.

The experimental findings show that the dielectric constant of the system $ZnO.TiO_2$–$1 \cdot 5MgO.TiO_2$ in a wide range of concentrations remains practically constant when the second component is partly replaced by the first (70–75% by weight of $ZnTiO_3$). This may be explained by the fact that the electronic polarizability of the Zn and Mg ions is equal and that the radii of the Zn^{2+} and Mg^{2+} ions are also nearly equal. The crystal lattice has thus always roughly the same structure, as is confirmed by X-ray investigations. The temperature coefficient of the dielectric constant increases slightly with $ZnTiO_3$ concentration. The differences in the dielectric characteristics between mixed titanates of the spinel and perovskite types are discussed with reference to their differing structures which permit of a perfect interpretation of the empirical data. B. F. KRAUS

537.226.3

7012. Investigation of the dielectric losses of low-frequency relaxing in polyethylene. G. P. Mikhailov, A. M. Lobanov and B. I. Sazhin. *Zh. tekh. Fiz.*, **24**, *No.* 9, 1553–60 (1954) In Russian.

The existence of such losses in polyethylene was established. They could be shown to be connected with the orientation of the polar groups in the crystal phase. The l.f. relaxation time is slightly reduced by distension of the polyethylene specimens, whereas that of the h.f. relaxation losses is extended by specimen distension, in agreement with experience on dipole-elastic losses of amorphous polymers.

ELECTRICAL RESEARCH ASSOCIATION

537.226.3

7013. The temperature relation of the dielectric loss coefficient ϵ'' of polar polymers. P. F. Veselovskiĭ. *Zh. tekh. Fiz.*, **25**, *No.* 2, 266–9 (1955) In Russian.

Fuoss–Kirkwood's empirical equation may be used for explaining the reduction or increase of $\tan \delta$ in the range of the maximum with a variation of the temperature or of the frequency of the applied alternating field. The value of $\tan \delta$ at the maximum depends on the ratio α/T. For the dipolar-radical dielectric losses the distribution parameter of the relaxation times is practically temperature-independent, but $\tan \delta_{max}$ falls with rising temperature, and vice versa.

ELECTRICAL RESEARCH ASSOCIATION

537.226.32 : 621.3.011.5 : 621.319.2

7014. Abnormal increase in the dielectric constant of an electret-forming material. S. D. Chatterjee and T. C. Bhadra. *Phys. Rev.*, **98**, *No.* 6, 1728–9 (*June* 15, 1955).

An electret with its two surfaces covered by plates which are connected together presents a situation in which the average (zero) field between the plates is composed to two equal and opposite parts, one due to the polarization and the other due to the charges on or adjacent to the plates. These opposing fields can be very large ($\sim 10^6$ V/cm) and as a result, large fluctuations may be expected in the vicinities of individual molecules. For these reasons it is surmised that the dielectric constant of the material of an electret may show an abnormal value, depending upon "strength" of the electret. The experiments described verify the existence of such an abnormality. A.

537.226.33

7015. Investigation of the dielectric polarization of organic dipolar crystals. G. I. Skanavi and A. N. Gubkin. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12), 742–53 (1954) In Russian.

The relations between dielectric constant and loss angle of hydrogenized castor oils (oleowaxes), and the frequency, were investigated at the temperatures of 19 and 45°C. The experimental data obtained enabled parameters characterizing the relaxation polarization to be calculated. The distribution function of the relaxation times was also found. The results are discussed on the basis of the theory of absolute reaction rates. A refinement of Debye's theory had to be used considering the fact that the relaxation times of dipolar groups differ according to the strength of the bond (Debye's theory considers only a single relaxation time equal for all groups). The problem of finding the most probable relaxation time from the dispersed experimental values is solved by a graphical method using a particular type of circle diagrams. The dielectric relaxation phenomena are then considered from a thermodynamical (thermochemical) viewpoint, i.e. that of the absolute reaction rates. B. F. KRAUS

537.226.8 : 621.3.015.5 : 621.315.618.2

7016. Mathematical analysis of the dielectric strength of compressed air. M. Bichara. *Rev. gén. Elect.*, **64**, *No.* 3, 159–62 (*March*, 1955) In French.

Data from an investigation by N. J. Félici and Y. Marchal [*ibid.*, **57**, 155–62 (*April*, 1948), Abstr. 2135 B (1948)] have been analysed. It is pointed out that at high pressures (~30 atm) Paschen's law is not obeyed and it is suggested that the deviation is due to cold emission from the electrodes. It is shown that at high pressures larger field strengths can be attained when the electrodes are of stainless steel than when they are of aluminium, but the latter is better for low pressures. A. E. KAY

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 537.312.8

7017. Resistance of metals at high current densities. V. V. Bondarenko, I. F. Kvartskhava, A. A. Plyutto and A. A. Chernov. *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 191–8 (1955) In Russian.

The results of an experimental investigation of the relation between the resistance of some metals, viz. copper, silver, platinum, etc., at current densities up to 10^7 A/cm^2 are presented. The investigation was partly intended to find explanations for the phenomenon known as wire explosion, and also to determine the limitations of the validity of Ohm's law, if any. However, according to classic electron theory appreciable deviations from Ohm's law should occur only in the range 10^{10}–10^{11} A/cm^2 which cannot be reached experimentally yet. Modern refinements of

the theory indicate that the limits of the accurate validity of Ohm's law must be some orders of magnitude lower than the above value, though such deviations are said to have been observed at densities of $\sim 10^6$ A/cm^2. These results did not stand up to carefully arranged tests, and the authors found Ohm's law satisfied at the highest current densities produced in their experiments. The currents were produced by an impulse circuit supplied by a capacitor discharge and oscillograms of the pulse form were taken. The energy relations obtained did not reveal any definite dependence of the resistance of the metal on the energy evolved and introduced into the wire. The experimental curves also enabled extrapolations to higher current ranges to be obtained by comparing the trends and relative extremes of the different metals investigated and therefore to conclude on a validity of Ohm's law up to at least $6{\cdot}5\times10^7$ A/cm^2 for copper, 6×10^7 A/cm^2 for silver, $1{\cdot}5\times10^7$ for tungsten and $2{\cdot}5\times10^7$ for platinum. At the highest current densities the temperature of the wires does not exceed a few hundred °C, but it is possible to obtain such current densities even at moderate temperatures. Even if a wire explosion is obtained (with W or Pt) at liquid-air temperature, the character of the energy-relation of R does not vary. B. F. KRAUS

537.311.3

7018. A new method for measuring electrical resistivities. K. G. RAMANATHAN AND J. S. DHILLON. Letter in *Nature* [*London*] **175,** 948 (*May* 28, 1955).

The ballistic throw θ of a ring of known dimensions of the substance being investigated when a magnetic field H at 45° to its axis is suddenly switched off enables the resistivity ρ to be calculated from the relation $\theta = A^2TH^2a/8\pi I\rho L$, where A, L, a, I are the area, length, cross-section and moment of inertia of the ring, and T its time of oscillation. W. M. LOMER

537.311.3 : 538.632

7019. Theoretical basis for the measurement of resistivity and the Hall constant by the point method. J. LAPLUME. *Onde élect.*, **35,** 113–25 (*Feb.*, 1955) In French.

The "point method" is explained. The four points involved may be collinear, or at the corners of a square. In each case the theory for measuring the resistivity is developed. Then the theory for the Hall constant is discussed. [Some of the mathematical developments are well known and might well have been quoted to save space.] L. S. GODDARD

537.311.31

7020. On the theory of the electrical resistance of ordered alloys. M. A. KRIVOGLAZ AND Z. A. MATŸSINA. *Zh. éksper. teor. Fiz.*, **28,** *No.* 1, 61–9 (1955) In Russian.

The residual resistance of ordered binary alloys is considered in the framework of a many-electron theory. It is shown that the dependence of the resistance on the composition and the degree of long-range order is the same as in the one-electron approximation. Correlation in alloys is considered.

J. M. RADCLIFFE

537.311.31 : 537.531 : 535.343 : 539.11

Brillouin zones, electrical conductivity of metals and X-ray *K* absorption spectra. *See Abstr.* 7228

537.311.31 : 539.23

7021. Conductivity of thin metallic films. M. I. KAGANOV AND M. YA. AZBEL'. Letter in *Zh. éksper. teor. Fiz.*, **27,** *No.* 6 (12), 762–3 (1954) In Russian.

Considers the effect of film thickness on the distribution function for electrons within the metal.

J. M. HOUGH

537.311.31 : 548.7

7022. The electrical resistance and crystalline structure of the alloys Au_3Mn and AuMn in the temperature range −183 to 700°C. A. GIANSOLDATI AND J. O. LINDE. Letter in *J. Phys. Radium*, **16,** *No.* 4, 341–2 (*April*, 1955) In French.

Results of measurements on $30\times1\times1$ mm bars. A change of slope in the resistivity *v.* temperature curve for AuMn at 500°K indicates a Néel point of antiferromagnetic transformation. The transformation for Au_3Mn at 923°K is an order-disorder change but the one at 150°K is probably another Néel point.

C. A. HOGARTH

537.311.32

7023. An experimental contribution on the field excitation of electrons from levels in the forbidden zone. H. GUTJAHR AND E. GUTSCHE. Note in *Z. Naturforsch.*, **10a,** *No.* 4, 342–3 (1955) In German.

Measurements of the field-excited glow curves of CdS [see Abstr. 6623 and 8322 (1954)] show that electrons are removed from levels in the forbidden zone during this process and also in dielectric breakdown of the crystals. G. F. J. GARLICK

537.311.32

7024. Pressure dependence of the resistivity of silicon. W. PAUL AND G. L. PEARSON. *Phys. Rev.*, **98,** *No.* 6, 1755–7 (*June* 15, 1955).

The variation of resistivity of high-purity single crystals of silicon has been measured as a function of hydrostatic pressure in the intrinsic range. The results are interpreted to give a decrease in energy gap between conduction and valence bands with applied pressure. A.

537.311.32 : 539.374

7025. Effect of plastic deformation on the electrical conductivity of silver bromide. W. G. JOHNSTON. *Phys. Rev.*, **98,** *No.* 6, 1777–86 (*June* 15, 1955).

Plastic deformation of AgBr at and below room temperature produces a conductivity increase that varies linearly with strain. The conductivity increase has a low activation energy, exhibits dispersion at low frequencies, and recovers slowly at room temperature. A small anisotropy in the conductivity increase can be produced which indicates that the increase is greater parallel to the slip planes than perpendicular to them. The conductivity increase is attributed to regions of disorder that are introduced by the deformation, and these regions of disorder appear to be piled-up groups of dislocations in the slip planes of the work-hardened crystal. A.

537.311.32 : 621.315.616.9

7026. Conductivity induced by X-rays in polyethylene terephthalate: a possible insulator for radiological apparatus. J. F. FOWLER AND F. T. FARMER. *Nature* [*London*] **175,** 590–1 (*April* 2, 1955).

Melinex sheet (as fibre Terylene) shows an induced conductivity less than that of other plastics and

current decays within a few seconds following exposure, to a small fraction of its equilibrium value. Current $\propto$ (dose rate)$^{\cdot 83}$, and the temperature-dependence shows an activation energy under irradiation of 0·2 eV. The static value is 1·3 eV. The high static insulation, coupled with these factors, makes the material superior to amber for instruments exposed to X- or γ-radiation. F. T. FARMER

537.311.33

7027. Theory of the photomagnetic effect in semiconductors in strong magnetic fields. A. I. ANSEL'M. *Zh. tekh. Fiz.*, **24**, *No.* 11, 2064–9 (1954) In Russian.

The photomagnetic effect, discovered by Kikoin and Noskov in 1934, consists in the fact that in an irradiated semiconductor in an homogeneous magnetic field parallel to the irradiated surface, an electric field is set up normal to the optical beam and magnetic field. This field is calculated for magnetic fields $uH/c \geqslant 1$, where u is the mobility of the current carriers. The theory considers ionic semiconductors at low temperatures and atomic semiconductors.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33

7028. Some relationships about the value of the thermal conductivity of semiconductors. A. V. IOFFE AND A. F. IOFFE. *Dokl. Akad. Nauk SSSR*, **97**, *No.* 5, 821–2 (1954) In Russian.

One of the authors had pointed out that the phonon part of the thermal conductivity of semiconductors must decrease with increasing atomic weight and with more marked anharmonic character of the thermal oscillations. The quantitative results obtained by the authors with an improved set-up, and also those obtained by other workers, confirm these predictions, as discussed in the present communication.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33

7029. On the theory of the magnetic properties of atomic semiconductors. I. L. L. KORENBLIT. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12), 719–27 (1954) In Russian.

Computes the susceptibility of a pure semiconductor, starting from a "polar" model of a crystal. The results are compared with those obtained within the framework of the zone picture. J. M. RADCLIFFE

537.311.33

7030. Contribution to the $1/f$ law for noise in semiconductors. H. SCHÖNFELD. *Z. Naturforsch.*, **10a**, *No.* 4, 291–300 (1955) In German.

The hypothesis of noise arising from changes in conductivity due to minority-carrier injection is investigated and a time variation of the form $1/t^{\frac{1}{2}}$ is found to fit the results. This variation leads to a $1/f$ law. C. A. HOGARTH

537.311.33

7031. On the theoretical temperature coefficients of semiconductors. E. GROSCHWITZ. *Z. angew. Phys.*, **7**, *No.* 5, 245–9 (1955) In German.

The temperature coefficient of resistance of semiconductors is derived for materials of varying degrees of purity and for different temperature ranges. The temperature effects of p–n junctions are determined from the diffusion currents of the minority carriers.

C. A. HOGARTH

537.311.33

7032. On the theoretical temperature coefficients of junction transistors. E. GROSCHWITZ. *Z. angew. Phys.*, **7**, *No.* 6, 280–2 (1955) In German.

See also preceding abstract. The temperature coefficient of resistance of a p–n junction is found to arise from two causes: (*a*) a voltage-dependent negative coefficient depending on the energy gap, and (*b*) a positive coefficient due to the change in minority carrier lifetime. C. A. HOGARTH

537.311.33

7033. Considerations on the localization of the phenomena of generation and recombination at contact barriers and at the surface of a semiconductor. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 16, 1634–6 (*April* 18, 1955) In French.

Trapping centres (recombination and generation) are considered to lie at the free surface of a semiconductor and in the space-charge region of a p–n junction. This assumption may explain various experimental facts, including semiconductor noise.

C. A. HOGARTH

537.311.33

7034. Auger effect in semiconductors. L. PINCHERLE. Letter in *Proc. Phys. Soc. B*, **68**, *Pt* 5, 319–20 (*May*, 1955).

It is pointed out that the Auger effect (the converse of impact ionization) may be an important cause of recombination of holes and electrons in impure semiconductors. A formula is derived for the Auger lifetime, applying when the recombination occurs at deep traps, which is in order of magnitude agreement with recent experimental data on Si [Abstr. 2750 (1955)]. L. PINCHERLE

537.311.33

7035. Calculation of the space charge, electric field, and free carrier concentration at the surface of a semiconductor. R. H. KINGSTON AND S. F. NEUSTADTER. *J. appl. Phys.*, **26**, *No.* 6, 718–20 (*June*, 1955).

In the study of the surface properties of semiconductors, it is valuable to know the relation between carrier density at the surface and the shift in electrostatic potential from the bulk to the surface. By a solution of Poisson's equation utilizing Boltzmann statistics, the space charge, electric field, and change in free carrier concentration have been calculated for a semiconductor surface. The results are expressed as a function of the deviations of the Fermi energy from its intrinsic value in the bulk and at the surface. The calculated curves may be used for any nondegenerate semiconductor at any temperature, provided that the donor and acceptor levels are completely ionized. Numerical values are given for germanium and silicon at room temperature. A.

537.311.33 : 536.2.022

7036. The problem of the variation of the thermal conductivity of semiconductors in a magnetic field. K. I. AMIRKHANOV, A. Z. DAIBOV AND V. P. ZHUZE. *Dokl. Akad. Nauk SSSR*, **98**, *No.* 4, 557–60 (1954) In Russian.

Experiments to establish whether or not semiconductors showed the thermomagnetic Maggi–Righi–Leduc effect were carried out with negative

results on Te, MoS_2, Bi_2Se_3, Bi_2Te_3 and PbTe in transverse magnetic fields up to 11 000 oersted; if existing at all, the effect must be $<0{\cdot}2\%$. An appreciable increase of the thermal resistance was observed only on Bi and HgSe, which agrees with theoretical predictions.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33 : 537.226.1

7037. Dielectric characteristics of the transition layers in semiconductors. B. M. Vul. *Zh. tekh. Fiz.*, **25**, *No.* 1, 3–10 (1955) In Russian.

A theoretical investigation of a model of a semiconductor slab, the left-hand half of which possesses deficiency conductivity, and the right-hand half, electronic conductivity. Electrons will diffuse from the right to the left side and owing to this a double layer of space charges will be set up at the separation, or in the transition layer. The author calculates the differential capacitance, resistance and dielectric losses of the transition layer.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33 : 539.11

7038. Forbidden and allowed bands in impurity semiconductors and disordered alloys. J. des Cloizeaux. *J. Phys. Radium*, **16**, *No.* 4, 320–4 (*April*, 1955) In French.

Theoretical analysis of the limits of energy bands in a one-dimensional model of a semiconductor or disordered alloy. This is represented by a series of cells of types *A* and *B*. The results show that permitted energy bands do exist outside the bands allowed by considering an infinite succession of cells of one type only, *A* or *B*. This result disagrees with that of Saxon and Hutner (1954). C. A. HOGARTH

537.311.33 : 548.734

7039. The study of semiconductor crystal perfection by X-ray diffraction methods. P. J. Holmes. Note in *Brit. J. appl. Phys.*, **6**, *No.* 5, 180–1 (*May*, 1955).

The essential feature of the method is the use of a micro-focus source in conjunction with a collimator giving a fine, near-parallel beam. The appearance of a back reflection Laue spot then depends only on the character of the crystal under examination. Examples of the technique applied to non-perfect crystals of Ge and Si are given. C. A. HOGARTH

537.311.33 : 621.315.59

7040. Transport properties of a many-valley semiconductor. C. Herring. *Bell Syst. tech. J.*, **34**, *No.* 2, 237–90 (*March*, 1955).

The simple model of a semiconductor, based on a single effective mass for the charge carriers and a spherical shape for the surfaces of constant energy, is now known to be inadequate for most of the semiconductors which have been extensively studied experimentally. However, some of these do correspond to what may be called the "many-valley" model, a model for which the band edge occurs at a number of equivalent points $\mathbf{K}^{(i)}$ in wave-number space, and for which the surfaces of constant energy are multiple ellipsoids, one centred on each of these points. This paper develops, for models of this type, the theory for: mobility and its temperature dependence; thermoelectric power; piezoresistance; Hall effect; h.f. permittivity; and magnetoresistance. These phenomena are treated, for cases to which Maxwellian statistics apply, on the assumption that the scattering of the charge carriers is describable by a relaxation time which depends on energy only, but is otherwise unrestricted. This assumption can be shown to be justified in a large class of cases, although for some cases it fails, notably when ionized impurity scattering predominates and at the same time the effective mass is very anisotropic. Special attention is given to the role of inter-valley lattice scattering, i.e. to processes whereby a charge carrier is scattered from the neighbourhood of one of the band edge points $\mathbf{K}^{(i)}$ to the neighbourhood of a different one. Numerical calculations show the effects of such processes on the magnitudes and temperature variations of the effects listed above. A.

537.311.33 : 621.315.59

7041. Semiconductor characteristics of some high-resistance metal alloys. A. I. Drabkin. *Zh. tekh. Fiz.*, **25**, *No.* 1, 81–4 (1955) In Russian.

Shows that the resistivity of a number of high-resistance alloys has a negative temperature coefficient. This fact indicates that these alloys have marked semiconductor characteristics and may be used for breeding improved alloy types for thermal compensation of resistances in measuring instruments, production of wires for strain gauges, and other uses. ELECTRICAL RESEARCH ASSOCIATION

537.311.33 : 621.315.59

7042. Electronic fluctuations in semiconductors. R. E. Burgess. *Brit. J. appl. Phys.*, **6**, *No.* 6, 185–90 (*June*, 1955).

In many systems the limiting sensitivity is determined almost entirely by the noise of a semiconductor device. The various types of spontaneous fluctuation are reviewed and compared with the corresponding processes in vacuum tubes. Particular attention is paid to modulation noise conspicuous in semiconductors at l.f., especially when current-carrying contacts or barriers occur. A.

537.311.33 : 537.312.5

7043. Photoelectric conductivity of cadmium sulphide. H. Frank. *Slaboproudý Obzor*, **15**, *No.* 9, 435–43 (1954) In Czech.

In introduction the author describes the basis of the internal photoelectric effect, indicates the relation between the absorption of light and photoelectric conductivity, and attempts to explain all the phenomena on the basis of the energy-level model of semiconductors. A survey of the theory of exceeding the quantum equivalent is given and the frequency dependence of the photoelectric effect is discussed. The technological procedure for obtaining photoelectrically sensitive CdS is examined. The properties of crystalline CdS are surveyed, with particular attention to the photoelectric properties in the visible, ultraviolet and X-ray bands. The influence of oxygen is discussed in detail. In conclusion the author presents his own experiments with photoelectric CdS and indicates possible applications, particularly for the detection of X-rays. A.

537.311.33

7044. Study of the semiconduction of cupric oxide by means of its magnetic behaviour between 80 and 1000°K. N. Perakis and A. Serres. *J. Phys. Radium*, **16**, *No.* 5, 387–94 (*May*, 1955) In French.

The free ferromagnetic impurities of CuO containing an oxygen excess of 0·9% expressed as copper vacancies Cu^+ in the formula $Cu_{11}(Cu^+)O_6$ make it a *p*-type semiconductor. Measurements from 80 to 1000°K show that it possesses a variable paramagnetism and a weak diamagnetism or constant paramagnetism due to the rest of the molecule. Above 360°K the constant paramagnetism obeys Curie's law and is due to the copper ions and free holes. The hole concentration is calculated for the temperature range 80 to 1000°K and is found to increase to $5{\cdot}1\times10^{20}$ at 360°K and then remain constant. This value corresponds to one-ninth of the excess oxygen. C. A. HOGARTH

537.311.33 : 539.217

Diffusion of antimony, arsenic and indium in solid germanium. *See Abstr.* 7414

537.311.33 : 548.7

7045. The electrical effects of dislocations in germanium. W. T. Read, Jr and G. L. Pearson. *Defects in crystalline solids* [*Bristol*] 143–52. See Abstr. 5707 (1955).

Gives a simple picture of Read's theory of dislocations in germanium in which a dislocation is regarded as a line of closely spaced acceptors which give rise to an energy level near the middle of the forbidden band. The theory suggests further experiments which may help explain the effect of dislocations on such quantities as minority-carrier lifetime. C. A. HOGARTH

537.311.33

7046. Charge carrier susceptibility and cyclotron resonance of germanium. C. Enz. *Helv. phys. Acta*, **28**, *No.* 2–3, 158–66 (1955) In German.

The present theories of the energy-band structure of germanium are tested by comparing with Busch and Helfer's experimental results for the charge carrier susceptibility of germanium in the intrinsic range. If for the conduction band 4 ellipsoids of revolution are taken the error is 30%; if 8 are taken the error is 90%. C. A. HOGARTH

537.311.33

7047. Attempt to detect high mobility holes in germanium using the drift mobility technique. N. J. Harrick. Letter in *Phys. Rev.*, **98**, *No.* 4, 1131–3 (*May* 15, 1955).

A very careful experiment using a 5 ohm cm *n*-type germanium filament, In-alloy emitter and collector, magnetic biassing to increase the collector signal, and other refinements failed to detect the high-mobility holes predicted by Dresselhaus, Kip and Kittel (1953) from cyclotron resonance experiments. C. A. HOGARTH

537.311.33

7048. Surface recombination in germanium in the presence of strong electric fields. H. K. Henisch and W. N. Reynolds. *Proc. Phys. Soc. B*, **68**, *Pt* 6, 353–6 (*June*, 1955).

Strong electric fields have been applied in a direction normal to the surfaces of germanium single crystals; such fields have been shown to have a large effect on the surface recombination velocity of injected minority carriers. The variation is in the same sense for *n*-type and *p*-type samples. A possible theoretical model for this asymmetry is discussed. A.

537.311.33

7049. Microwave determination of the average masses of electrons and holes in germanium. J. M. Goldey and S. C. Brown. *Phys. Rev.*, **98**, *No.* 6, 1761–3 (*June* 15, 1955).

Free current carriers in a medium make a contribution to its dielectric coefficient. The present experiment utilizes this effect to determine the effective masses of electrons and holes in germanium by measuring the microwave dielectric coefficient at several temperatures. The dielectric coefficient was determined by measuring the complex transmission coefficient at 24·15 kilomegacycles/sec through a thin slab of germanium. The effective mass for electron was $(0{\cdot}09 \pm 0{\cdot}05)m_0$; for holes it was $(0{\cdot}30 \pm 0{\cdot}05)m_0$. A.

537.311.33 : 539.185

7050. Fast-neutron bombardment of *n*-type Ge. J. W. Cleland, J. H. Crawford, Jr and J. C. Pigg. *Phys. Rev.*, **98**, *No.* 6, 1742–50 (*June* 15, 1955).

The effect of fast-neutron bombardment on the electrical properties of *n*-type Ge has been extensively studied by a variety of experiments. The initial rate of carrier removal, the shape of the bombardment curve, and the temperature dependence of electron concentration in bombarded specimens all indicate the production of two vacant states, one located below the middle of the forbidden energy band and the other located $\sim$0·2 eV below the conduction band. These two vacant states are consistent with predictions of the model of James and Lark-Horovitz. Studies of mobility reveal that the additional scattering associated with bombardment-induced lattice disorder is more complex than charged impurity scattering in that it exhibits a much greater temperature dependence and is markedly dependent on electron concentration. Low-temperature exposure and subsequent warming experiments indicate that appreciable photoconductivity associated with minority-carrier trapping results from fast-neutron bombardment. The important minority-carrier traps appear to anneal during warming below room temperature. A.

537.311.33

7051. Influence of recombination at the contact on the V-A characteristics of a rectifier. A. V. Rzhanov. *Dokl. Akad. Nauk SSSR*, **98**, *No.* 3, 389–90 (1954) In Russian.

A system is considered consisting of an electron conductivity type semiconducting layer at one of whose faces there is a strong electron-hole transition, whereas the other is covered with a non-active contact at which a certain rate of surface recombination is maintained. The V-A characteristic of the system is derived for various hole concentrations and diffusion path lengths of the holes, first under the assumption that hole concentrations $\ll$ electron concentrations, and then for large hole concentrations.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33 : 621.314.634

7052. Low-capacitance Se rectifiers. S. POGANSKI. *A.E.G. Mitt.*, **45**, *No.* 3–4, 257–60 (*March–April*, 1955) In German.

Describes the construction of low capacitance Se rectifiers which operate up to 300–600 kc/s.

C. A. HOGARTH

537.311.33

7053. Observation on the temperature dependence of the back current of *p–i–n* rectifiers. A. HERLET. *Z. angew. Phys.*, **7**, *No.* 5, 240–4 (1955) In German.

Theoretical analysis using the trap model of Shockley–Read and Hall as a starting point. For a truly intrinsic middle zone the saturation back current varies as $\exp(-E/kT)$ where E is less than the gap width. For weakly doped middle zones the exponent takes different values in different temperature ranges.

C. A. HOGARTH

537.311.33 : 621.314.7

7054. Forming procedures for silicon point-contact transistors. J. W. GRANVILLE, W. BARDSLEY AND A. F. GIBSON. *Brit. J. appl. Phys.*, **6**, *No.* 6, 206–10 (*June*, 1955).

Methods of forming have been established. Suitable whisker materials for use as emitters and collectors on *n*- and *p*-type silicon and the necessary pulsing techniques are described. Using these forming procedures, silicon transistors have been made with increased power gains and with output characteristics of the correct type. The performance figures of typical formed silicon transistors are quoted.

A.

537.311.33

7055. Reverse current and carrier lifetime as a function of temperature in germanium junction diodes. E. M. PELL. *J. appl. Phys.*, **26**, *No.* 6, 658–66 (*June*, 1955).

The reverse current and carrier lifetime have been measured in a series of germanium diodes as a function of temperature between room temperature and liquid nitrogen temperature. The lifetime reaches a plateau at low temperatures, and its behaviour can be explained in terms of the Hall–Shockley–Read recombination theory. Log i_R *v.* $1/T$ exhibits a break to a shallower slope at lower temperatures, which can be explained in terms of charge generation by recombination centres in the space-charge region.

A.

537.311.33

7056. Water-vapor-induced *n*-type surface conductivity on *p*-type germanium. R. H. KINGSTON. *Phys. Rev.*, **98**, *No.* 6, 1766–75 (*June* 15, 1955).

By utilizing a direct reading instrument it is possible to measure the *n*-type surface conductance of the *p*-type germanium in an *n–p–n* junction transistor as a function of relative humidity, ambient gas, and surface treatment. The results of these measurements indicate that the leakage conductance from the emitter to the collector may be predicted on the basis of a constant electron density at the surface which is independent of the applied bias but a critical function of the oxidation of the surface and the adsorbed gas. This conductance exhibits a transient character upon change in applied bias which may be correlated with similar transients in the conductance of a thin germanium crystal upon application of an external applied field. This comparison establishes that the inversion layer is caused by ionization of surface impurities rather than migration of ions along the surface. From the results of the experiments it is postulated that the density and type of carrier at the surface of an etched germanium crystal are a function of the surface treatment and gaseous ambient rather than the acceptor and donor density of the bulk germanium.

A.

537.311.35 : 539.213

7057. The electrical conductivity of glasses. II. The conductivity of Li–Na, Na–K, K–Li-mixed glasses. B. LENGYEL AND Z. BOKSAY. *Z. phys. Chem.* [*Leipzig*] **204**, *No.* 3–4, 157–64 (*May*, 1955) In German.

For Pt. I, see Abstr. 2759 (1955). The electrical conductivities of these glasses were investigated for their dependence on the alkali ratio and on temperature. The results support the theory given in Pt I of the conductivity of mixed glasses.

W. GOOD

537.312.5

7058. State of photoelectric research. W. KLUGE. *Z. angew. Phys.*, **7**, *No.* 6, 302–11 (1955) In German.

A general review of research, published mainly since 1949, on photoelectric emission from various types of surface, including pure metals, mixtures of alkali metals with Sb, etc., oxide and alkali-halogen layers, and semiconductors. 122 refs.

J. DUTTON

537.312.5

7059. On the development and maintenance of the photoelectric effect of an antimony/caesium layer in vacuum. A. LALLEMAND AND M. DUCHESNE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1329–31 (*March* 21, 1955) In French.

The sensitivity can be maintained by depositing the layer on electrolytic copper and cooling to −55°C.

C. A. HOGARTH

537.312.5 : 535.371

Infrared emission bands and kinetics of emission and photoconduction in CdS in temperature region of quenching of luminescence. *See Abstr.* 6939

537.312.5 : 537.311.33

7060. Optical and impact recombination in impurity photoconductivity in germanium and silicon. N. SCLAR AND E. BURSTEIN. *Phys. Rev.*, **98**, *No.* 6, 1757–60 (*June* 15, 1955).

The impact (three-body) recombination and optical recombination coefficients are calculated for hydrogen-like impurity centres in extrinsic germanium and silicon in thermal equilibrium. These have been compared with the phonon recombination coefficient calculated by Gummel and Lax for a similar model. It is found that the optical coefficient is always less than the phonon coefficient in the temperature range of interest. The impact ionization coefficient which is proportional to the free carrier concentration may be comparable with or greater than the phonon recombination coefficient at 4·2°K in the presence of background radiation and definitely exceeds it at higher temperatures. Comparison with experimental data indicates that none of the mechanisms considered can yet explain the observed time constants.

A.

537.312.5 : 537.311.33

7061. Rectifying effect and photo-e.m.f. of selenium photo-elements and non-additivity of their photoconductivity. Z. A. Gol'dman. *Dokl. Akad. Nauk SSSR*, **97**, *No.* 3, 415–16 (1954) In Russian.

Selenium photoelements with strong rectifying effect were investigated by obtaining their voltage/current characteristics with external voltages applied, for dark current and under intense illumination by short and long waves separately, and combined. Under intense short-wave illumination the rectifying characteristic becomes linear. When a certain limit is exceeded, the space charge characterising, according to Schottky, the "dark" rectification is removed and a photo-e.m.f. set up.

ELECTRICAL RESEARCH ASSOCIATION

537.312.5 : 621.383.27

7062. Some remarks as to dark current and pulse-height distribution in E.M.I. 6260 photomultipliers. I. Pelchowitch. *Rev. sci. Instrum.*, **26**, *No.* 5, 470–4 (*May*, 1955).

Bias curves measured with an E.M.I. 6260 photomultiplier tube for dark current, and single photoelectrons emitted from the cathode under light stimulation, are discussed. It is shown that the dark current has a multi-electron emission component, the major part of which can be attributed to the K^{40} content of the glass. Pulse-height distributions are shown to be dependent on focusing characteristics of the multiplier and to broaden when space-charge limitation occurs. A.

537.312.5 : 621.383.27

7063. The characteristics of photomultiplier tubes and their use for absorption measurements. K. W. Keohane and W. K. Metcalf. *J. sci. Instrum.*, **32**, *No.* 7, 259–60 (*July*, 1955).

Estimates have been made of the uniformity of the spatial characteristics of type 1P21 photomultiplier tubes and their variation with wavelength. These tubes have remarkably uniform characteristics (~0·5%) and the area of maximum sensitivity of the photocathode can be repeatedly located to a similar order of accuracy. It is suggested that the errors demonstrated by Edels and Gambling [Abstr. 5631 (1954)] are due to their experimental method rather than a true representation of the spatial characteristics of the photocathode. Linearity of the photomultiplier input/output characteristics has been measured for the range 2–0·05 μA and no departures from linearity can be detected within the experimental accuracy (0·5%). A.

537.312.5 : 621.383.27.018.75

7064. A method of estimating photomultiplier pulse durations and shapes. B. Meltzer, J. A. Lodge and P. L. Holmes. *J. sci. Instrum.*, **32**, *No.* 7, 270–1 (*July*, 1955).

The measurement of the output spectrum of a photomultiplier is proposed for obtaining information on the duration and shape of the current pulse, which is useful for an estimate of resolving time and for the design of pulse-shaping circuits. Some experimental tests are described. A.

537.312.62

7065. Concerning investigations on anisotropy in the surface impedance of tin at low temperatures. M. S. Khaĭkin. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 115–17 (1955) In Russian.

Discusses Pippard's results [Abstr. 8754–6 (1950)]. It is concluded that these results can be understood as being due to a mixing of modes in the cavity by a sample having a tensorially anisotropic impedance, and that the experiments to date do not provide conclusive evidence for Pippard's hypothesis of a non-tensorial anisotropy. J. M. Radcliffe

537.312.62

7066. Theory of the Meissner effect in superconductors. J. Bardeen. Letter in *Phys. Rev.*, **97**, *No.* 6, 1724–5 (*March* 15, 1955).

Assuming that in the superconducting state a finite energy $\varepsilon \sim kT_c$ is required to excite electrons from the surface of the Fermi sea and that electrons so excited behave much like electrons in the normal state, first-order perturbation by the magnetic field gives the essential feature of the Meissner effect, viz. a definite value for the penetration depth λ. This differs somewhat from $\lambda_0 = (mc^2/4\pi e^2 n)^{\frac{1}{2}}$ of the London theory which postulated that the wave-functions are not modified by the magnetic field. Thus any model which gives correctly the thermodynamical properties of the superconducting state will most likely give the Meissner effect. H. London

ELECTRIC DISCHARGES 537.52

537.52 : 621.3.015.5

7067. A circumstance in which arise conduction currents and displacement currents of comparable magnitude. A. Greenwood. *Proc. Leeds Phil. Lit. Soc.*, **6**, *No.* 4, 254–7 (*Dec.*, 1954).

If part of an electric circuit consists of an ionized gas through which current flows as clouds of ions, the displacement current is comparable in magnitude to the conduction current. The case dealt with is that of the point-to-plane gap. A. J. Small (R)

537.521

7068. Electrical breakdown in high vacuum. W. S. Boyle, P. Kisliuk and L. H. Germer. *J. appl. Phys.*, **26**, *No.* 6, 720–6 (*June*, 1955).

Currents preceding breakdown have been measured between closely spaced tungsten electrodes in high vacuum. It is found that field emission currents sufficient to evaporate anode metal flow before breakdown. These currents follow the Fowler–Nordheim equation when field magnification due to surface irregularities on the cathode is taken into account. The field magnification is a function of distance at electrode separations less than 4×10^{-4} cm. Explanation of the observed breakdown at low voltage and small spacing requires an unusually high yield of electrons at the cathode per ion formed in the gap. Furthermore there is no measurable direct enhancement of the current by ionization even at higher voltages. The high electron yield must therefore exist over the entire observed range of breakdown voltages.

This high yield is satisfactorily accounted for by the increase in field emission due to the positive ion space charge, which in turn increases the positive ion current density until there is breakdown. It is shown that breakdown occurs when the field emission current is increased by only 65%. This condition is reached with the ion current density much smaller than the electron current density. A.

537.521.4

7069. Study on Lichtenberg's figures by means of color films. I–III. B. Arai. *Sci. Rep. Yokohama Nat. Univ. I, No.* 1, 27–38 (*March*, 1952); *No.* 2, 41–6 (*March*, 1953); *No.* 3, 20–32 (*March*, 1954).

Lichtenberg figures were recorded on some Japanese colour films. The background was found to be red, while with black paper shielding the film surface, the colour became dark olive-green. Photomicrographs of sections of the emulsion show the distribution of silver particles in the emulsion, and the known colour film properties then explain the colours recorded. Practical details and sample colour photographs are given. R. W. FISH

537.523 : 537.528 : 621.3.015.5 : 621.385.032.2 : 621.315.618

7070. Measurement of the statistical time lag of breakdown in gases and liquids. R. F. Saxe and T. J. Lewis. *Brit. J. appl. Phys.*, **6**, *No.* 6, 211–16 (*June*, 1955).

It has been shown by earlier workers that the observation of the statistical distribution of time lags to breakdown of small spark gaps may provide information on the emission of electrons from the cathode. This paper discusses the restrictions imposed by this method of measurement of cathode emission. Since the measuring technique causes the surface being investigated to undergo a change, efficient spark quenching should be provided to minimize this change. A circuit providing this is described, together with a novel circuit to record a set of time lags automatically. Preliminary experiments show that "conditioning" of the cathode surface in air is now more rapid than that obtained previously, and the reasons for this are discussed. Application of the method to the breakdown of small gaps in *n*-hexane indicates that the behaviour is similar to that of a gap in air in that "conditioning" of the cathode surface and a statistical variation of time lags occur. A.

537.523.3 : 621.3.015.532

7071. Investigations on the ultra-corona discharge. C. A. E. Uhlig. *Dissert. E.T.H. Zürich, Paper* 2237, 342 *pp.* (1954) In German.

The pre-discharge phenomena and breakdown voltages in air are investigated systematically of quasi-uniform gaps (sphere gaps, 250 mm) and non-uniform gaps (rod-sphere, 250 mm gap, wire-sphere, point-sphere and crossed wires). Specific attention is given to a novel form of positive discharge (ultra-corona discharge) which develops at the tip of a fine point or around a thin wire and which consists of a reddish-violet zone of illumination round the wire in which very strong space charges are formed which are so distributed as to produce a uniform field strength. The complete absence of brush or streamer formation in this form of discharge results in a very large increase of the breakdown voltage obtainable with arrangements in which these discharge characteristics can be utilized. Thus it is claimed that, in a high-voltage laboratory with an effective clearance of 6·5 m, disturbing streamer discharges occurred at a test voltage of 1 000 $kV_{r.m.s.}$ with the best conventionally designed h.v. testing equipment whereas, after introduction of the improved h.v. termination, a test voltage of 1 600 $kV_{r.m.s.}$ could be applied with a clearance of 1·2 m. The major part of the thesis describes the test equipment developed to produce stabilized d.c. and a.c. voltages and a special form of impulse voltage with linear voltage increase variable between 0·001 and 1 000 kV/μsec. A further test circuit produces an impulse voltage with linear front superimposed on a d.c. voltage. The major test results are presented in series of curves in which the breakdown voltages are plotted as a function of the front steepness of the applied voltage. The curves shown cover a range of gap settings, different wire diameters, and both polarities of the various types of test voltage specified. The physical properties of the various discharge mechanisms are examined and the results obtained are compared with existing information on spark and corona discharges. R. H. GOLDE

537.523.3 : 539.23 : 539.217.1

Detection of pores in varnish layers by corona discharge. *See Abstr.* 7417

537.523.4

7072. A study of time-resolved spectra of long sparks. A. Vassy. *J. Phys. Radium*, **16**, *No.* 4, 292–5 (*April*, 1955) In French.

Enumerates various emission lines and bands for long sparks in air. The discharge shows three main phases, namely a predischarge regime lasting ~20 μsec, followed by an intense discharge lasting ~1 μsec and finally a "post-luminescence" lasting ~30 μsec, depending on the experimental conditions. A rotating mirror camera was used. Spark lengths varied from 17–155 cm. J. D. CRAGGS

537.523.5

7073. Low-voltage short duration arcs between separating contacts in low voltage substantially non-inductive circuits. J. Riddlestone. Letter in *Nature* [*London*] **175**, 909 (*May* 21, 1955).

Describes experiments on arcs in 6 V circuit with inductances between 0·06 and 117 μH, for breaking currents between 1·3 and 5·6 A. The existence of short duration arcs in these conditions is confirmed by oscillograms, two of which are shown.

J. D. CRAGGS

537.523.5 : 537.525.5

7074. Plasma streaming in arcs caused by self-magnetic compression. H. Maecker. *Z. Phys.*, **141**, *No.* 1–2, 198–216 (1955) In German.

Discusses various experiments which demonstrate streaming of a plasma (in an originally axial direction). It is suggested that the streaming originates in the region of constricted discharge near the cathode, due to the pinching caused by the self-magnetic field. The theory is developed. Various experimental cases of discharges are briefly discussed, although the main part of the paper deals with high-current carbon arcs in air. Currents are ~100 A. J. D. CRAGGS

537.523.5 : 621.315.5.066.6 : 621.3.014.31

7075. Arcing at electrical contacts on closure. VI. The anode mechanism of extremely short arcs. W. S. Boyle and L. H. Germer. *J. appl. Phys.*, **26**, *No.* 5, 571–4 (*May*, 1955).

For Pt V, see Abstr. 9270 (1954). The erosion at the anode of a short arc has been studied as a function of the arc duration and the magnitude of the arc current. With the current maintained at a constant value the anode pit grows continuously in diameter up to a critical value of the order of 10μ; when this size is reached, a new arc is initiated and a new pit starts to develop. The process may be repeated. Consideration of the heat loss from the anode shows that for a constant arc power the pressure of metal vapour between the electrodes is very sensitive to the area covered by the arc. An order of magnitude estimate of the minimum metal vapour pressure required to maintain the arc ($\sim$100 atm) yields a value of the maximum pit diameter in good agreement with the experimental observations. It is evident that the steady-state short arc does not exist, and quantities such as the metal transfer, ion to electron current ratio, and pressure in the arc are dependent on the time since the initiation of the arc. A.

537.525

7076. Retrograde motion in gas discharge plasmas. K. G. Hernqvist and E. O. Johnson. *Phys. Rev.*, **98**, *No.* 6, 1576–83 (*June* 15, 1955).

It has been discovered that the glow region of the ball-of-fire mode in a hot-cathode discharge exhibits retrograde motion like the cathode spot of a mercury pool arc. The dependence of the velocity of motion on magnetic field, gas pressure, and current has been studied. Measurements have been made on tubes simulating the geometry and flow conditions of the ball-of-fire mode of discharge. A mechanism for retrograde motion is proposed. An expression for the velocity of motion is derived based on the stability criterion for a space charge sheath connecting two plasmas. Conclusions from a possible analogy with the mercury pool arc are made. A.

537.525.5

7077. The existence and demonstration of point emission from mercury surfaces. H. v. Bertele. *Acta phys. Austriaca*, **9**, *No.* 2, 124–50 (1955) In German.

Commences with a review of some of the earlier work on the physics of cathode spots in mercury pool arcs. Current densities, temperatures and velocities of spot movement, etc., are discussed. The heat conduction in the spot region is then discussed. Various special electrode systems are described. There are 35 references. J. D. CRAGGS

537.525.5

7078. On the kinetic theory of homogeneous plasmas. M. Bayet, J.-L. Delcroix and J.-F. Denisse. Letter in *J. Phys. Radium*, **16**, *No.* 5, 431 (*May*, 1955) In French.

A brief note relating the general plasma theory given previously [Abstr. 2776 (1955)] with earlier work, on a special case of the theory, by Kober [Abstr. 2429 (1953)]. J. D. CRAGGS

537.525.5 : 535.33.03 : 538.6

7079. Motion and spectrum of arc cathode spot in a magnetic field. R. M. St John and J. G. Winans. *Phys. Rev.*, **98**, *No.* 6, 1664–71 (*June* 15, 1955).

The velocity of the cathode spot of a mercury arc at the junction between liquid and metal in a transverse magnetic field has been measured for magnetic field strengths between 0 and 20 700 Oe. The approximate doubling of retrograde velocity at about 11 000 to 15 000 Oe was followed by an additional rapid rise of velocity at about 15 000 Oe. Spectra of the arc showed Hg II and Hg III lines at the stronger magnetic fields. Radiation from the cathode spot showed mercury lines and a continuous spectrum which is especially intense at the lines. Some Hg lines are broadened symmetrically and others asymmetrically. If the broadening is due to a Stark effect, the electric field strength in the cathode spot region is greater than 6×10^6 V/cm. The arc mechanism previously proposed is extended to explain the rapid velocity rises with increasing magnetic field strength by associating them with the effect of Hg^{++} and Hg^{+++} ions. A.

537.525.5 : 537.525.8

7080. The kinetic theory of feebly ionized homogeneous plasmas. II. M. Bayet, J.-L. Delcroix and J.-F. Denisse. *J. Phys. Radium*, **16**, *No.* 4, 274–80 (*April*, 1955) In French.

For Pt I, see Abstr. 2776 (1955). The theoretical treatment of plasma problems is extended to the effect of the electric field on the energy distribution of electrons, and the energy interchange relations between the electron and gas atom (or molecule) swarms. J. D. CRAGGS

537.525.5 : 537.525.8

7081. The positive column in discharges carrying varying currents. T. Wasserrab. *Z. angew. Phys.*, **7**, *No.* 4, 176–9 (1955) In German.

Discusses the variation of electron (or ion) density with time in a plasma through which the current is varying. Low-pressure discharges are considered, with emphasis on diffusion processes as controlling mechanisms. Mercury-arc rectifiers are discussed briefly as a practical application of the theory. J. D. CRAGGS

537.525.5 : 537.525.8

7082. The influence of the inhomogeneity of plasmas on their resonance frequency. A. Esprester and A. Haug. *Z. angew. Phys.*, **7**, *No.* 4, 180–3 (1955) In German.

Discusses the effect of spatial variations in electron density in a discharge column (those occurring in a radial direction are considered) on the resonance frequency. The Tonks–Langmuir theory may thus, it is claimed, be brought into better agreement with experimental data. Formulae containing the appropriate correction factors are set out. J. D. CRAGGS

537.525.5 : 537.525.8 : 537.562

7083. The complete interpretation of probe characteristics for plasmas containing several electron-groups. W. H. Schneider. *Acta phys. Austriaca*, **9**, *No.* 2, 107–23 (1955) In German.

Describes experiments with plane and cylindrical

probes in low pressure Hg discharges. Many current–voltage probe characteristics are shown covering the whole range of positive ion and electron collection regimes. Secondary probe effects and errors are discussed. The significance of different electron groups is also treated. J. D. CRAGGS

537.525.8

7084. Investigation of the h.v. discharge by the probe method. KH. A. DZHERPETOV AND G. M. PATEYUK. *Zh. éksper. teor. Fiz.*, **28**, *No.* 3, 343–51 (1955) In Russian.

The existing variants of the probe method are compared in application to He, Ne, A and H_2 discharges. The deformations of the discharge caused by the introduction of auxiliary electrodes, the so-called "counter-probes," into the discharge spaces are considered, as well as the distributions of temperature, electron concentration and potential along the axis of the discharge vessel, and the relations between these parameters and the gas pressure and the h.f. field strength at the electrodes.

ELECTRICAL RESEARCH ASSOCIATION

537.525.8

7085. Diffusion in moving striations. V. D. FARRIS. Note in *Proc. Phys. Soc. B*, **68**, *Pt* 6, 383–5 (*June*, 1955).

Extends the theory of positive column striations to include the effects of diffusion; the results are applied to experimental data of Pupp. Discrepancies between ionization rates determined in different ways are discussed. These differences could be due to inaccurate experimental data. J. D. CRAGGS

537.525.8

7086. Microwave study of positive ion collection by probes. G. J. SCHULZ AND S. C. BROWN. *Phys. Rev.*, **98**, *No.* 6, 1642–9 (*June* 15, 1955).

The theory of the positive ion saturation region of probes at low pressure is modified to take into account the directed current at the sheath edge. This drift current explains the discrepancy between the theoretical and experimental ratio of the electron saturation probe current to the positive ion saturation probe current. The theory is checked by using microwave methods to obtain an independent measurement of the ion density. Probe and microwave measurements are compared in the pressure region of 0·05–6 mm Hg in hydrogen, argon and helium. A.

537.525.8

7087. Field measurements in glow discharges with a refined electron beam probe and automatic recording. R. WARREN. *Phys. Rev.*, **98**, *No.* 6, 1650–8 (*June* 15, 1955).

By using a very sensitive and fully automatic magnetically compensated electron beam probe, the design of which is described elsewhere, studies were made of the fields in glow discharges some 40 cm long in a tube 10 cm in diameter with aluminium and copper cathodes at from 0·03 to 1·0 mm Hg pressure with currents ranging from 0·1 to 10 mA in flowing air, nitrogen, hydrogen, helium and argon which were pure to 99·5%, but contaminated by vapours from various stopcock greases, waxes and clean, but not outgassed, metals. Simultaneously, wall potentials and luminosities of the glows were measured and spectra of the cogent parts of the discharges were observed. Emphasis centred on the fields in the Crooke's dark space for discharge currents ranging upwards from the normal cathode fall region. Some stationary striations were also studied. The high resolving power obtained resulted in details of the dark space fields hitherto unrecognized which are amenable to theoretical interpretations to be given in a subsequent paper. Only the observed results are reported here. A.

537.525.8

7088. Interpretation of field measurements in the cathode region of glow discharges. R. WARREN. *Phys. Rev.*, **98**, *No.* 6, 1658–64 (*June* 15, 1955).

A theory for the cathode region of glow discharges is developed in which the major assumptions are: (*a*) electron emission from the cathode due to positive ion impact is the dominant secondary mechanism; (*b*) the probability of ionization by electrons occurring in the high-field cathode region is small, so that electrons carry a negligible portion of the total tube current there; and (*c*) in this region the positive ions drift towards the cathode with a velocity governed by a mobility law. This theory is found to agree well with measurements in abnormal discharges in various gases at pressures above about 0·1 mm Hg. For lower pressures, measurements indicate that a great number of electrons are present in the cathode-negative glow space, probably due to ionization by high-energy positive ions and molecules; and, that at high enough values of E/p, the application of a mobility theory becomes completely invalid. A.

537.529 : 537.226.8

7089. Some problems of the theory of the breakdown of inhomogeneous dielectrics. YU. M. VOLOKOBINSKIĬ. *Zh. tekh. Fiz.*, **25**, *No.* 1, 74–80 (1955) In Russian.

Phenomena taking place in air occlusions in electrical insulation are considered. It is shown that in strong fields the energy dissipated in unit time in an individual occlusion increases linearly with the field strength. The energy dissipated during a discharge is determined. An expression is given for the relaxation time of the dissipation of the charges collected on the surfaces of occlusions, and a formula for the field distortion and stress concentration by a conducting occlusion. Stress concentration is independent of the dielectric constant of the material.

ELECTRICAL RESEARCH ASSOCIATION

537.529 : 548.7

7090. Directional breakdown in alkali halide crystals. M. E. CASPARI. *Phys. Rev.*, **98**, *No.* 6, 1679–91 (*June* 15, 1955).

The d.c. breakdown strength of sodium chloride, shown by von Hippel and Davisson to be independent of orientation at room temperature, also proves to be direction-independent at liquid nitrogen temperature. Experiments at room temperature reveal the existence of three types of breakdown paths: anodic, cathodic and homogeneous field paths. Anodic paths are initiated by prebreakdown discharges at the anode and are precisely orientated with respect to the crystallographic axes. Cathodic breakdown paths are initiated at point cathodes; their direction dependence differs from that of anodic paths. Finally,

in strictly homogeneous fields the paths follow the direction of the field. Measurements on various alkali halides between −160° and 325°c under strictly controlled field conditions confirm the findings of Davisson that the anodic path directions follow the sequence: random → [100] → [111] → [110] with increasing temperature. [111] paths, observed only in sodium salts, are usually accompanied by [110] or [100] paths. While the random → [100] transition takes place gradually over a temperature range of more than 100°c, the [100] → [110] transition in potassium and rubidium salts is sharp. With overvoltage this acuteness of the transition disappears, the path directions are shifted towards lower temperature forms and the temperature range of [111] paths in sodium salts is greatly extended. Mechanical deformation has little effect on the path directions. A phonon-Brillouin zone picture, as used by Offenbacher and Callen, but modified for inhomogeneous fields, is in good qualitative agreement with these observations. The electronic-Brillouin zone boundary and the crystalline potential may also influence the path directions. A.

X-RAYS 537.531

537.531 : 535.33

7091. Emissions in the neighbourhood of absorption discontinuities in the *L* region of the X-ray spectra of the rare earths. P. Sakellaridis. *J. Phys. Radium*, **16**, *No.* 4, 271–3 (*April*, 1955) In French.

See Abstr. 10234 (1954). A systematic study for the elements Eu, Gd, Tb, Ho and Tm is reported. J. J. WILKINS

537.531 : 535.33

7092. Multiplets characteristic of the rare earths in their X-emission spectra. P. Sakellaridis. *J. Phys. Radium*, **16**, *No.* 5, 422–7 (*May*, 1955) In French.

See preceding abstract. Further systematic studies of the *L* spectra are reported. J. J. WILKINS

537.531 : 535.33

7093. Measurement of the wavelengths of maximum intensity for X-ray tube spectra. A. D. K. Laird. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 568–71 (*July*, 1955).

A new method is described for measuring the wavelength of peak intensity of X-ray tubes. This method employs known absorption data and gives an independent check on crystal spectrometer measurements. For a tungsten target tube, the measured values were: 50·0 kV spectrum peak at 0·337 Å, 45·5 kV at 0·367 Å, 39·8 kV at 0·416 Å and 33·5 kV at 0·478 Å. An important companion result is the variation of intensity with tube potential, at constant wavelengths shorter than the peak wavelengths, for spectra corresponding to tube potentials between 30 and 70 kV. A.

537.531 : 535.343

7094. Theory of X-ray absorption spectra. A. I. Kostarev and I. B. Borovskiĭ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 377–84 (1954) In Russian.

On the theory of X-ray absorption spectra. É. E. Vaĭnshteĭn, R. L. Barinskiĭ and K. I. Narbutt. *Ibid.*, **27**, *No.* 4 (10) 521–8 (1954) In Russian.

Review paper and discussion.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 539.172.3

7095. Calibration in energy of a 22 MeV betatron. R. Basile and C. Schuhl. *J. Phys. Radium*, **16**, *No.* 5, 372–7 (*May*, 1955) In French.

The known thresholds of the reactions (γ, n) on C^{12}, O^{16}, Cu^{63} and Ag^{109} are used. In extrapolating to the threshold it is supposed that the square root of the activation varies linearly with maximum photon energy; theoretical and experimental support is offered for this. Results obtained incidentally are the threshold of $13{\cdot}65 \pm 0{\cdot}05$ MeV for $Fe^{54}(\gamma, n)Fe^{53}$, and the difference 400 ± 60 keV in the thresholds of $Ag^{106}(\gamma, n)Ag^{105}$ and $Ag^{109}(\gamma, n)Ag^{108}$. J. S. BELL

537.533 : 621.384.62

7096. Some physical characteristics of a 45-MeV linear electron accelerator for therapeutic applications. E. M. Uhlmann and C. L. Hsieh. *Radiology*, **64**, *No.* 4, 587 (*April*, 1955).

The accelerator, which is designed for electron therapy, is installed at Michael Reese Hospital, Chicago. It employs an 18 MW klystron, and gives a continuous variation from 6 to 36 MeV (present limit), with a beam current of 1 μA. Biological and physical experiments are being made. F. T. FARMER (R)

537.533.2

7097. Work function of tungsten single crystal planes measured by the field emission microscope. E. W. Müller. *J. appl. Phys.*, **26**, *No.* 6, 732–8 (*June*, 1955).

The work functions of the low emitting crystallographic planes of tungsten, (011) and (112), are not well known. In previous experiments scattered secondaries and some other disturbing effects covered the small emission particularly of the (011) plane. A method combining the field emission microscope with a probe collector has been applied. The current density in the (011) plane turned out to be 4 to 5 orders of magnitude smaller than in strongly emitting planes. Applying the Fowler–Nordheim theory, ϕ_{011} was found between 5·70 and 5·99 eV and ϕ_{112} between 4·65 and 4·88 eV depending on the temperature at which the tungsten crystal has been annealed previously. This is not a temperature effect of the work function, but the result of freezing in thermal imperfections of the planes. The work function of the ideal (011) plane appears to be as high as 5·99 eV. The existence of such a high value is further suggested by the ionization of aluminium on a hot polycrystalline tungsten wire, indicating that a part of the surface has a work function as high as the 5·96 eV ionization energy of aluminium. A.

537.533.2

7098. Semi-empirical method of calculating the electronic work function of metals. W. M. H. Sachtler. *Z. Elektrochem.*, **59**, *No.* 2, 119–22 (1955) In German.

It is found that almost all measurements of work function of pure metals fit to within about 0·1 V the relation $\psi = 1{\cdot}58\,\mathrm{I} + 2{\cdot}47\delta$, where ψ is the work function, I the ionization potential of the atom, and δ the number of atoms per Å^2 on the most stable crystal face. Very light and very heavy atoms deviate

by up to 0·6 V. Lists of estimated work functions and for ionization energies of elements for which only one of these is known are given. W. M. LOMER

537.533.3

7099. Interference pattern of light intensity for electron waves using a biprism. H. DÜKER. Note in *Z. Naturforsch.*, **10a**, *No.* 3, 256 (1955) In German.

In a previous paper [Abstr. 3817 (1955)] the Fresnel biprism experiment was demonstrated for electron waves. The modification now introduced permits of direct viewing of the interference pattern. A 3 μ metallized quartz thread was used as electron-optical biprism maintaining +10 V approx. to the earth electrode at a distance of 2 mm. The electron source was tapered, using cylinder lenses. The very fine electron beam probe illuminated the electron-optical system. The equidistant interference fringes so obtained were magnified 160 times with cylinder lenses and displayed on the screen. In order to prevent the unevenness of the quartz thread from being observed the pattern was magnified 5–10 times in the direction of the fringes. Further magnification of 20 times permitted of direct viewing. For photography, the time of exposure was 1–2 sec.

Z. F. WOJNAR

537.533.3

7100. Improvement of the optics of the high-resolution electrostatic velocity analyser. G. MÖLLENSTEDT AND W. DIETRICH. *Optik*, **12**, *No.* 5, 246–9 (1955) In German.

The high-resolution electrostatic velocity analyser previously described by Möllenstedt [Abstr. 5038 (1950)] has been further developed. Originally the resolution decreased with increasing distance from the optical axis. By applying a suitable potential to the central electrode of the analysing lens, each part of the spectrum can be brought on to the axis in turn, where it falls on to a second slit. This gives a constant resolution for all parts of the spectrum and enables larger apertures to be used. By the use of a fluorescent screen under the second slit, a multiplier photocell and a pen recorder, the spectrum can now be recorded in a convenient manner. The energy loss spectrum of aluminium is given as an example.

A.E.I. RESEARCH LABORATORY

537.533.3 : 537.534.3

7101. Electron and ion bundles with curved axes—considered in terms of wave mechanics. H. GRÜMM. *Optik*, **12**, *No.* 4, 153–65 (1955) In German.

The geometrical-optical treatment of electron and ion beams is not entirely satisfactory, particularly where the intensity distribution is required. Previous authors have used wave mechanics to derive the electron optical properties of a system by setting up the appropriate Schrödinger equation for systems with a straight axis. The present author extends the theory to systems having a curved axis, e.g. beam deflection systems, mass spectrography, etc.

A.E.I. RESEARCH LABORATORY

537.533.31

7102. The aberrations of the third order of a typical electrostatic einzel lens. W. GLASER AND P. SCHISKE. *Optik*, **12**, *No.* 5, 233–45 (1955) In German.

In a previous paper [Abstr. 981–2 (1955)] the authors worked out the paraxial focal properties of a typical electrostatic lens. The present paper extends the calculations to five seidel aberrations as a function of the lens potentials and the position of the object. A.E.I. RESEARCH LABORATORY

537.533.331

7103. The properties of electrostatic unipotential lenses, whose axial potential very nearly reaches that of the cathode. W. LIPPERT. *Optik*, **12**, *No.* 4, 173–80 (1955) In German.

Lenses in which the axial potential is nearly that of the cathode are of interest as filtering lenses. The focal properties of such lenses are deduced by a combination of mathematical computation and direct experiments. It is found that five parameters are needed to specify the focal properties of the lens.

A.E.I. RESEARCH LABORATORY

537.533.335

7104. The measurement of the chromatic aberration constant of magnetic lenses. H. WATANABE AND N. MORITO. *Optik*, **12**, *No.* 4, 166–72 (1955) In German.

The axial chromatic aberration constant of a magnetic lens is difficult to measure experimentally since it usually appears as a disk of confusion. The authors show that the axial chromatic aberration causes an image shift if the contrast aperture of the objective is displaced sideways from the optical axis. This image shift varies linearly with change in accelerating voltage and with the angle that the electrons make with the optical axis. To measure the latter, a magnesium oxide crystal is used as an object, and a diffracted ray of known inclination is selected by the contrast diaphragm and imaged by a second lens on to a photographic plate. The values of chromatic aberration obtained from the shift of this ray with change in accelerating voltage agree well with theoretical calculations.

A.E.I. RESEARCH LABORATORY

537.533.35

7105. Electron microscopy by reflection: grazing angle, observation under a large angle. C. FERT, B. MARTY AND R. SAPORTE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1975–8 (*May* 16, 1955) In French.

By using grazing-incidence illumination and a large viewing angle (up to 25°) for reflection electron microscopy, images having a resolution as good as those obtained under grazing-incidence observation can be produced. Furthermore, the foreshortening of the image is less, giving more easily interpretable pictures with a greater sensitivity to the detection of relief detail. A.E.I. RESEARCH LABORATORY

537.533.72

7106. Self-focusing streams. W. H. BENNETT. *Phys. Rev.*, **98**, *No.* 6, 1584–93 (*June* 15, 1955).

Streams consisting of a mixture of ions and electrons in which the average velocity of the electrons in the direction of the stream is different from the average stream velocity of the ions can be magnetically self-focusing. The random velocities of the electrons and ions about their respective average stream velocities do not need to be Maxwellian. The only condition which must be met is that the total electric current in stream must exceed a critical value which

can be calculated in terms of the stream velocities and the average kinetic energies of the particles due to components of velocity transverse to the axis of the stream. Streams containing both slow and fast particles of like kind tend to eject the slow particles and keep the fast ones. Streams of particles of one kind only, entering an ionized or ionizable region can be self-focusing. Axial asymmetries grow in arcs but disappear in low-density self-focusing streams. A.

537.533.72 : 518.5 : 621.317.729

7107. Analogue study of electron trajectories. B. F. Logan, G. R. Welti and G. C. Sponsler. *J. Assoc. Comput. Mach.*, **2**, *No.* 1, 28–41 (*Jan.*, 1955).

Describes an automatic computer, used in conjunction with an electrolytic tank, giving both field maps and trajectory plots. Circuit components, tank and probe assembly are described. The most serious error is due to the drop in tank water level by evaporation. Errors in the measured field components, and those due to finite probe dimensions, are removed by corrective networks. The system was calibrated using a special tank with concentric cylindrical electrodes. A tracer was used to assess the merits of different electrode configurations in c.r. tubes using post-deflection acceleration; 250 trajectories for 6 different configurations were plotted in 2 days, with reproducibility of better than ½%. Several improvements are suggested. N. M. KING

537.533.73

7108. Electron diffraction equipments. H. C. Corbet, G. M. van Koppen, J. Kramer, M. van Ments, J. B. Le Poole and L. L. van Reijen. *Optik*, **12**, *No.* 5, 215–25 (1955) In German.

Four electron diffraction equipments are described, developed according to the principles described previously by van Ments [*Proceedings of the Conference on Electron Microscopy*, Delft, 1949, pp. 35–7]. Magnetic lenses are used in such a way that the variations in accelerating voltage and lens current have only a small effect on the diffraction pattern, thus enabling a simplification of the electrical supplies to be made. A further development has been to incorporate in the diffraction camera an auxiliary filament. This serves as an h.t. rectifier, enabling considerable economies to be made in the h.t. supply unit. A.E.I. RESEARCH LABORATORY

537.533.73

7109. Energy analysis of electron diffraction patterns. H. Watanabe. Note in *J. Phys. Soc. Japan*, **10**, *No.* 4, 321–2 (*April*, 1955).

The diffracted electrons in electron diffraction patterns are examined by an analyser lens and their energy spectra determined. It is found that the diffracted beams contain an appreciable fraction of inelastically scattered electrons, a circumstance attributed to the occurrence of inelastic scattering after the initial elastic scattering. J. THEWLIS

537.533.74

7110. Inelastic scattering of electrons from a cuprous oxide surface. N. B. Gornyĭ. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11) 649–51 (1954) In Russian.

This was studied for primary electrons of energy 21·5, 100 and 130 eV from monocrystalline (100 and 110 planes) and polycrystalline surfaces of cuprous oxide. Experimental arrangement and method for curve correction are described schematically. Energy losses through inelastic scattering agree with theoretical prediction. S. DEDIJER

537.533.74

7111. Radiative corrections to electron scattering. R. G. Newton. Letter in *Phys. Rev.*, **98**, *No.* 5, 1514–15 (*June* 1, 1955).

A previous result [Abstr. 4726 (1955)] was in error. Correction of this changes the dependence for high energies completely. G. E. BROWN

537.533.74

7112. Radiative corrections to electron scattering. M. Chrétien. Letter in *Phys. Rev.*, **98**, *No.* 5, 1515–16 (*June* 1, 1955).

In second-order Born approximation terms in $\ln E/m$—but not in $\ln^2 E/m$ or higher powers—occur. This conclusion is valid for any static potential. G. E. BROWN

537.533.74

7113. Effect of finite nucleus on the radiative correction. L. R. B. Elton. Letter in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 549 (*June*, 1955).

Radiative corrections in lowest-order Born approximation are the same percentage of the uncorrected cross-section for all potentials. G. E. BROWN

537.533.74

7114. Scattering of high-energy electrons by nuclei. A. E. Glassgold. *Phys. Rev.*, **98**, *No.* 5, 1360–9 (*June* 1, 1955).

Calculations of elastic scattering of electrons have been carried out for simple, spherically symmetric charge distributions. The atomic numbers considered are $Z = 13$, 29, 50, 74 and 79, and the electron energy varies from 15 to 90 MeV. The results for the homogeneous and shell distributions indicate that shape independence exists for energies such that $kR_h \lesssim 1{\cdot}5$, where R_h is the radius of the homogeneous model and k is the electron wave-number. This is a consequence of requiring that these two densities have the same mean square radius or second moment. The assumption that the scattering at higher energies depends on higher even moments has also been investigated. The scattering was calculated as a function of the fourth moment at an energy just above the shape independent region. Equating the second and fourth moments of two charge densities results in identical scattering for scattering angles up to 120°, but beyond this point the scattering differs by about 10%. An analysis of the existing experiments below 100 MeV indicates that the mean square radius of the nuclear charge density is given by a homogeneous distribution of radius $R_h = r_0 A^{\frac{1}{3}} \times 10^{-13}$ cm, with $r_0 = 1{\cdot}2$ to within 10%. A.

537.533.75

7115. Energy loss of fast electrons. An investigation into the absolute total cross-section for bremsstrahlung in nuclear research emulsions. A. G. Ekspong. *Ark. Fys.*, **9**, *Paper* 14, 531–53 (1955).

The energy loss of fast electrons has been studied in detail. Previous experiments are summarized and some new results are presented. Values of the

radiation lengths (giving values of the total cross-sections for bremsstrahlung) at various high energies are obtained by following electron tracks produced in the emulsion by electrons in the cosmic radiation. A rigorous selection was enforced: only tracks whose length exceeded 10 000μ in one emulsion were taken. The energies of the electrons were determined from measurements of the multiple scattering. The experimental results are compared with those to be expected from the Bethe–Heitler theory and good agreement is obtained. D. J. PROWSE

537.533.75

7116. Ionization by relativistic particles. B. T. PRICE. *Rep. Progr. Phys.*, **18**, 52–82 (1955).

A summary is given of the theories of the relativistic increase of energy-loss by ionization and the density effect. The experimental evidence is then discussed and compared with theoretical predictions in a number of sections, each dealing with a particular experimental technique: proportional counters, cloud chambers, low-pressure Geiger counters, photographic plates, crystal counters and scintillators. A brief description is also given of experiments in which the energy-loss of fast electrons in thin foils is measured. 117 refs. A.

537.533.75

7117. Theory of electron penetration. L. V. SPENCER. *Phys. Rev.*, **98**, *No.* 6, 1597–615 (*June* 15, 1955).

The theory of electron penetration in an infinite medium under the combined influence of scattering and slowing down is developed to the point of numerical application. Sample calculations of energy dissipation *v.* distance from the source are compared with experiments by Frantz, by Clark, Brar, and Marinelli, and by Loevinger. The agreement is good provided that relativistic scattering cross-sections are used. The energy loss is treated in the continuous slowing down approximation; the resulting error is appreciable only at extreme penetrations. A.

537.533.75

7118. Passage of charged particles through plasma. J. NEUFELD AND R. H. RITCHIE. *Phys. Rev.*, **98**, *No.* 6, 1632–42 (*June* 15, 1955).

The plasma has been treated phenomenologically as a homogeneous dispersive medium characterized by a "dielectric constant" which is a function not only of the frequency of the applied field (as in conventional dispersive media) but also on its wave number. The representation of plasma as a dispersive medium is subject to certain validity criteria which are satisfied for such typical cases as the ionosphere and electrical discharge through gases but is not satisfied for electrons in the conduction band of a metal. The passage of charged particles through plasma is investigated by means of straightforward application of Maxwell's equations for a dispersive medium. The Debye screening, which is applicable to the potential of an incident particle having velocity $V \ll \langle v^2 \rangle^{\frac{1}{2}}$ (where $\langle v^2 \rangle^{\frac{1}{2}}$ is the root mean square velocity of plasma electrons), loses its significance when $V \gg \langle v^2 \rangle^{\frac{1}{2}}$; and in the latter case, the potential decreases with the distance in accordance with an inverse cube law. The stopping power has been calculated for slow incident charged particles having $V \ll \langle v^2 \rangle^{\frac{1}{2}}$ and for fast particles having $V \gg \langle v^2 \rangle^{\frac{1}{2}}$ in a plasma comprising electrons distributed in accordance with Maxwell–Bolzmann and Fermi–Dirac statistics. For slow particles the results represent an extension of the formula of Fermi and Teller. An expression has been derived for the distribution of the polarization density in the space surrounding a moving particle. A.

537.533.75

7119. Direct measurement of the effect of polarization on energy loss. E. L. GOLDWASSER, F. E. MILLS AND T. R. ROBILLARD. *Phys. Rev.*, **98**, *No.* 6, 1763–5 (*June* 15, 1955).

The energy losses suffered by 15·7 MeV electrons in traversing samples of about one gram per cm^2 of absorber in gas and solid form have been measured. Two pairs of absorbers have been used; perfluorocyclobutane gas and its polymer, tetrafluoroethylene resin, Teflon, and chlorotrifluoroethylene gas and its polymer, Kel-F plastic. The losses measured were of the order of one MeV and the resolution of the apparatus made possible an accuracy of 20 keV. The measured losses compared with theoretical predictions are as follows: Teflon; gas 1·33 MeV by experiment and 1·33 MeV by theory; solid 1·27 MeV by experiment and 1·24 MeV by theory: Kel-F; gas 1·29 MeV by experiment and 1·33 MeV by theory; solid 1·09 MeV by experiment and 1·11 MeV by theory. A.

537.533.75

7120. Auxiliary conditions in the Bohm–Pines theory of the electron gas. E. N. ADAMS. Letter in *Phys. Rev.*, **98**, *No.* 4, 1130–1 (*May* 15, 1955).

It is pointed out that the auxiliary conditions which have to be imposed on the wave-functions which occur in the Bohm–Pines theory of the electron gas with Coulomb interaction imply a more serious restriction than had so far been supposed. The consequences are briefly indicated. P. T. LANDSBERG

537.533.75 : 530.162 : 539.11

7121. Experimental evidence for the collective nature of the characteristic electron-energy losses in solids. D. GABOR AND G. W. JULL. *Nature* [*London*] **175**, 718–20 (*April* 23, 1955).

The energy losses suffered by electrons in their passage through gold foils were measured by a new electrostatic spectrograph. The nature of these losses is explicable on the theory of collective interaction proposed by Bohm and Pines [Abstr. 1278 (1954)], according to which they are due to the transfer of energy to the vibrational modes of the electron gas in the metal, with certain qualifications. J. THEWLIS

537.533.75 : 530.162 : 539.11

7122. On the interaction of electrons in metals. J. HUBBARD. *Proc. Phys. Soc. A*, **68**, *Pt* 5, 441–3 (*May*, 1955).

It is suggested that the long-range interactions of the electrons in metals can be treated as though the metal were a dielectric medium, and the connection between this approach and the plasma theory of Bohm and Pines [Abstr. 1278 (1954)] is indicated. A formula is given for the energy loss spectrum of fast electrons passing through a metal. E. H. SONDHEIMER

537.533.8

7123. Secondary electron emission from thin layers of Be. I. I. M. Bronshteĭn and T. A. Smorodina. *Zh. éksper. teor. Fiz.*, **27**, *No.* 2(8) 215–23 (1954) In Russian.

The secondary electron emission of thin layers of Be adsorbed on Ni was investigated as a function of the thickness of the Be layer and the energy of the primary electrons. The results are presented graphically. J. HUGHES

537.533.8

7124. The delayed electron emission of metals [bombarded with electrons]. K. Seeger. *Z. Phys.*, **141**, *No.* 1–2, 221–36 (1955) In German.

Describes experiments on a bombarded tungsten specimen placed in a high vacuum, investigating also the effect of thermal and mechanical surface treatment and of changes of the exciting voltage. The emitted electrons are counted by means of an electron multiplier. The emission centres are believed to be imperfections in an oxide surface layer which act as temporary electron traps, the delay time being a function of the temperature. Heating the specimen to 600°C causes the trapped electrons all to be emitted; heating to 1 000°C causes the traps themselves to be destroyed, so that no further delayed electrons are emitted. New traps may be formed subsequently by mechanical treatment of the oxide layer.

E. P. WOHLFARTH

537.533.8

7125. High-energy secondary electrons. B. L. Miller. Letter in *J. chem. Phys.*, **23**, *No.* 3, 599 (*March*, 1955).

Studies of the yield of high-energy secondary electrons from solid targets (Be, Al, Cu, Ag, W and Au) bombarded by high-energy electrons indicate a downward trend away from a linear Z-dependence towards low Z. [See also Abstr. 491 (1955).] This seems consistent with the effect of nuclear shielding on the multiple scattering of the primary beam.

A. O. STANESBY

537.533.8

7126. Secondary electron emission. S. Rodda. *Nature* [*London*] **175**, 1112–14 (*June* 25, 1955).

Brief report of a colloquium sponsored by the Institute of Physics and the Physical Society, in March.

537.533.9 : 537.534.9

7127. Measurement of the Čerenkov radiation from positive and negative Pi-mesons. J. R. Winckler, E. N. Mitchell, K. A. Anderson and L. Peterson. *Phys. Rev.*, **98**, *No.* 5, 1411–15 (*June* 1, 1955).

Cherenkov light pulses from individual π^+ and π^- mesons from the Chicago cyclotron have been measured by using photomultipliers and Lucite radiators. An analysis of the pulse-height distributions has been made for comparing the velocity dependence of the radiation with the predictions of classical theory. Theory and experiment are in substantial agreement. However, saturation was found to set in at a somewhat lower energy than theory predicts for an end-window type tube (Dumont type 6363). A search was made for a difference in the photoeffect produced by positive and negative particles radiating Cherenkov light. The effect was found to be less than about 3%, the limit of resolution being determined by magnetic effects on photomultiplier gain. A.

537.533.9 : 539.23

7128. Effect of the base metal on the electron dissociation of deposited BaO films. T. Imai and N. Shibata. Note in *J. Phys. Soc. Japan*, **9**, *No.* 6, 1034–5 (*Nov.–Dec.*, 1954).

Anodes of Ni and Ti were compared. Electron bombardment dissociates the film of BaO on Ti much more markedly than the film on Ni. In spite of the high affinity of Ti for O_2 a large evolution of gas is observed. A. H. W. BECK

537.534 : 537.223

7129. Electrostatic h.v. generator in compressed gas. B. V. Baev, P. E. Vorotnikov, B. M. Gokhberg, N. I. Sidorov, A. V. Shuf and G. B. Yan'kov. *Dokl. Akad. Nauk SSSR*, **101**, *No.* 4, 637–9 (1955) In Russian.

General description of an electrostatic generator designed for the acceleration of ion beams of comparatively low energy. The generator works in an atmosphere of nitrogen and carbon dioxide under a pressure of 8 atm and it is proposed to use "elegas" later on. It generates 2·8 MV and the ion beam issuing from the accelerator is focused to a diameter of 1 mm and carries a current of 80μA.

ELECTRICAL RESEARCH ASSOCIATION

537.534

7130. Radiation damping in a particle accelerator with a circular magnetic focusing field. W. Humbach. Note in *Z. Naturforsch.*, **10a**, *No.* 4, 347–8 (1955) In German.

In addition to the damping occasioned by the rotational motion, radiation losses arise from the vertical and radial oscillations of the particle. An upper limit for these losses is given in terms of the maximum radial excursion, and a parameter characterizing the radial inhomogeneity of the field. It is concluded that in certain circumstances these losses could contribute appreciably to the total damping.

E. A. ASH

537.534

7131. Orbit stability in the strong-focusing synchrotron. J. Seiden. *Ann. Phys.* [*Paris*] **10**, 259–304 (*March–April*, 1955) In French.

Presents a review of the main problems in the dynamics of strong-focusing synchrotrons. The effects of straight sections, magnet misalignments, field errors and twists on the particle orbits are discussed and a brief description given of the method of choosing a working point for the machine.

A. J. EGGINTON

537.534 : 621.319.523

7132. Characteristics of a high-frequency Cockcroft–Walton voltage source. R. A. Peck, Jr. *Rev. sci. Instrum.*, **26**, *No.* 5, 441–4 (*May*, 1955).

Direct voltage output and ripple from a conventional cascade rectifier voltage multiplier have been observed under various conditions of operating

frequency, load current, and number of doubler stages. Four types of voltage "loss" and two of ripple are identified, and their dependence on the above parameters is discussed. For six units operated at 32 kc/s the "voltage efficiency" varies from 90% without load to 80% when 8 mA are drawn; at 60 c/s it is 42% without load. From the nature of the loss and ripple components it is clear that there is a maximum fruitful operating frequency for a supply of this type, only slightly above 800 c/s in the present case. A.

537.534.3

7133. Radial focusing of the ion beam in a linear accelerator by charged grids. M.-Y. BERNARD. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 16, 1636–8 (*April* 18, 1955) In French.

Suggests that radial defocusing in Alvarez machines could be overcome by placing grids inside the drift-tubes, and raising them to a high potential, ϕ. Advantages envisaged are: (i) grids protected from r.f. and so can be made more transparent; and (ii) it may be possible to vary ϕ to avoid coupling resonances between phase and radial oscillations. N. M. KING

537.534.3

7134. Second-order direction focusing mass spectrographs with rectilinear image curve. H. HINTENBERGER, H. WENDE AND L. KÖNIG. Note in *Z. Naturforsch.*, **10a,** *No.* 4, 344 (1955) In German.

A condition relating the radii of the centre orbit in the electric and magnetic field of a double-focusing mass spectrograph is given which ensures (1) double first-order energy focusing for all masses, and (2) second-order direction focusing for one mass. This condition applies when the entrance slit is the focus of the electric field and when the end face of the magnet is a straight line passing through the point where the ion enters the magnetic field. H. MOTZ

537.534.3

7135. Magnetic semicircular spectrography of radioactive sources of low specific activity. R. J. WALEN. *J. Rech. Cent. Nat. Rech. Sci.*, **6,** 156–68 (*March*, 1955) In French.

A mathematical investigation is made of the optimum disposition of the source. It is shown that with the arrangement currently used a notable gain in resolution is obtained by de-centring the source with respect to the slit. J. S. BELL

537.534.3

7136. Performance of the nonmagnetic radio-frequency mass spectrometer tube. T. C. WHERRY AND F. W. KARASEK. *J. appl. Phys.*, **26,** *No.* 6, 682–6 (*June*, 1955).

The nonmagnetic radio-frequency principle of mass selection appears attractive because it promises to result in a mass spectrometer of simple construction and robust nature. Accurate evaluation of the use of the principle is difficult because of the lack of published performance data. In an effort to obtain performance data a 5-stage Bennett-type tube with stage separation of 5–9–4–7 cycles has been constructed and operational variables studied theoretically and experimentally. The experimental results are encouraging. They indicate the tube is capable of sufficient stability, resolving power, and sensitivity to be used for many analytical and research problems. Electronic circuits required to achieve a reasonable stability are relatively simple. A.

537.534.74

7137. Direction of proton spin polarization produced by elastic scattering. L. MARSHALL AND J. MARSHALL. *Phys. Rev.*, **98,** *No.* 5, 1398–401 (*June* 1, 1955).

A measurement has been made of the direction of spin polarization produced by elastic scattering of high-energy protons. 435 MeV protons were polarized by scattering elastically from beryllium to the right at 14° after which they were slowed to 0–20 MeV and scattered again elastically from helium. From the measured energies and angles of the scattered protons as recorded in photographic emulsions, together with the calculated polarizations resulting from interferences among the levels of the doublet P state involved in proton-helium elastic scattering, the polarization of the proton beam is found to be directed down. This result has been predicted by an hypothesis which extrapolates to high energies the effect of the spin-orbit coupling postulated for the nuclear shell model. A.

537.534.74 : 539.18

7138. The use of overlapping intervals in multiple scattering measurements. D. S. SCHONLAND. Note in *Proc. Phys. Soc. A*, **68,** *Pt* 5, 447–9 (*May*, 1955).

The accuracy gained by using doubly or triply, rather than singly overlapping intervals is not great. Curves of the errors are given. G. E. BROWN

537.534.75

7139. Energy loss by 8·86-MeV deuterons and 4·43-MeV protons. J. E. BROLLEY, JR AND F. L. RIBE. *Phys. Rev.*, **98,** *No.* 4, 1112–17 (*May* 15, 1955).

Using deuterons of average energy 8·86 MeV, the stopping powers relative to air have been measured for the following gases: H_2, He, N_2, O_2, Ne, A, Kr, Xe, CH_4 and CO_2. Absolute stopping cross-sections were measured, using 4·43 MeV protons (of equal velocity) for H_2, air and Kr, and the deuteron results were normalized to give absolute stopping cross-sections for all of the gases. Comparison is made with the theoretical results of Aron *et al.*, Walske, and Lindhard and Scharff. It was found that the NaI(Tl) crystal exhibited a nonlinearity in its response curve of light output v. proton or deuteron energy. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 535.33.07

7140. Photon counters for the far ultraviolet. T. A. CHUBB AND H. FRIEDMAN. *Rev. sci. Instrum.*, **26,** *No.* 5, 493–8 (*May*, 1955).

Photosensitive Geiger counters are useful for detection of ultraviolet radiation between 1 050 and 2 500 Å. The spectral sensitivities of such photon counters are determined by the photoelectric characteristics of the cathodes and the absorption and photo-ionization properties of the filling gases. Electronegative gases increase the cathode work function

and greatly reduce by negative ion formation the probability that a photoelectron will initiate a count. By proper combinations of gases to fix the long wavelength limit of counter sensitivity and filters to limit the short wavelength responses, it is possible to construct relatively narrow band detectors for the extreme ultraviolet. Such tubes have been used to study the solar spectrum from rockets and have been applied in the laboratory to absorption measurements of concentrations of gases such as H_2O in air and O_2 in the presence of H_2, N_2 and the rare gases. Characteristics of solid and gaseous materials useful in vacuum ultraviolet work are listed. A.

537.542

7141. On the subject of sensitive volumes of Geiger–Müller counters with external cathode. D. Blanc. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1280–1 (*June*, 1955) In French.

Describes various experiments on the effective counting length of external cathode counters, of the type due to Maze. J. D. CRAGGS

537.542

7142. A gas mixture for filling rapid ionization chambers, insensitive to contamination with oxygen. U. Facchini and A. Malvicini. Note in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1255–60 (*June*, 1955) In Italian.

Gridded ionization chambers using electron collection, while very precise instruments for measuring the energy of α-particles, are not well suited to quick operation. The filling gas must be freed of even a trace of electron-capturing gas or vapour. This requires careful evacuation of the chamber and prolonged purification of the filling gas. In contrast, mixtures of A and 2 − 4% N_2 give good counting characteristics with up to 0·5% O_2, much more O_2 than is found in commercially available supplies. No very special precautions need be taken. Thus α-particle spectra of short-lived emitters can be readily measured. Analysis of α-emitting nuclides contained in air is possible. A.

537.542 : 537.531.08

7143. The design of a condenser dose-meter. F. Harlen. *Brit. J. Radiol.*, **28**, 295–303 (*June*, 1955).

Factors in the design of instruments for the measurement of X-ray dose are considered with particular reference to a self-contained instrument using a quartz-fibre electroscope. Sufficient theory is given to show how manufacturing tolerances may be accommodated. The design of condenser ionization chambers is also discussed and three chambers are described. Results are given which show their suitability for their intended purpose and attention is given to effects to be expected when they are used at radiation qualities and intensities outside their normal working range. An appendix is devoted to the machining of polystyrene. A.

537.542 : 539.165.08

7144. Ionization chambers for the dosimetry of beta-ray applicators. J. L. Haybittle. *Brit. J. Radiol.*, **28**, 320–4 (*June*, 1955).

The measurement with ionization chambers of the dose-rate from β-ray applicators is discussed, with special reference to the effect of chamber diameter and the method of deducing the dose-rate at the applicator surface. Measurements on a P^{32} applicator with different types of chambers show that: (1) When the diameter of the collecting area in a small, shallow disc-shaped chamber is practically equal to the diameter of the air space in the chamber, significant errors may occur, due to (*a*) incorrect method of measuring the distance correction, and (*b*) uncertainty in the extrapolation from the nearest point of measurement to the surface. (2) A chamber of fixed depth, having an air space much larger in diameter than its collecting electrode, will give results in agreement with those obtained with an extrapolation chamber, and may therefore possibly be preferred to an extrapolation chamber in view of its ease of construction and the smaller number of experimental readings required. A.

537.542 : 621.383

7145. Phototube high-intensity gamma survey instrument. G. E. Koch, H. L. Gottfried, W. R. Lamb, F. A. Rhoads and J. Valdivia. *Rev. sci. Instrum.*, **26**, *No.* 5, 499–501 (*May*, 1955).

Many portable γ-radiation detection instruments employing either Geiger tubes or ionization chambers require collection potentials which are large compared to those needed for the operation of the other electronic components. This paper describes an instrument which uses a simple phototube-phosphor combination as the main detecting element with an inverted triode electrometer. It operates at potentials as low as 4½ V at radiation intensities from 5 mr/hr to 500 r/hr. A.

537.542

7146. Amplitude analysers of voltage pulses. A. A. Sanin. *Uspekhi fiz. Nauk*, **54**, *No.* 4, 619–42 (1954) In Russian.

Latterly the solution of many problems in contemporary experimental physics has involved the use of voltage-pulse-amplitude analysers, e.g. associated with scintillation or proportional counters, or in ionization chamber work. Only in the last few years has a score or two of designs appeared in periodicals. The author discusses briefly the required characteristics for such equipment. Some typical lay-outs are dealt with, all of which appeared originally in British or American publications. 17 references.

C. R. S. MANDERS

537.542

7147. A multichannel coincidence device. O. V. Protić and B. Vošicki. *Bull. Inst. Nuclear Sci. "Boris Kidrich,"* **5**, 29–35 (*March*, 1955).

A 16-channel device for investigating coincidence of pulses from radiation detectors and similar devices is described. The investigation can also be carried out with a smaller number of sources by excluding the superfluous channels. Registration of coincidence is made by means of a corresponding glow discharge tube on the front panel of the apparatus. The light of the glow discharge tubes is photographed and the results analysed. Thus it is possible to record about 300 coincidences per second. The sensitivity of the device is 0·1 V, with a rise time of input pulses of 1 μsec. A.

537.542

7148. Fast gated decade scaler using triodes. A. A. Šrebel. *Bull. Inst. Nuclear Sci. "Boris Kidrich,"* **5**, 43–4 (*March*, 1955).

537.542

7149. A continuous Wilson chamber with machine cooling. H. Klumb and G. Mix. *Z. angew. Phys.*, **7**, *No.* 6, 271–2 (1955) In German.

A Wilson cloud chamber of the Langsdorff diffusion type has been developed, having the cooling plant built in as the base of the chamber. Working range and performance of the chamber are indicated. Track photographs of typical high and low energy particles are given. D. V. MABBS

537.542

7150. Least-squares curvature [of cloud-chamber tracks] in non-uniform magnetic field. R. W. Thompson. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 4, 735–8 (*April*, 1955).

IONIZATION . THERMIONICS 537.56/.58

537.561

7151. Energies of normal and excited negative ions. D. R. Bates and B. L. Moiseiwitsch. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 540–2 (*June*, 1955).

Briefly discusses extrapolation procedures for the determination of electron affinities. New values of detachment potentials are derived using a modification of Glockler's method adapted for use with excitation potentials. The agreement with exptl. data is satisfactory. The bearing on this work of the new value of the detachment energy of O^- ($1{\cdot}45 \pm 0{\cdot}15$ eV) due to Branscomb and Smith is discussed. J. D. CRAGGS

537.562

7152. Potential measurements in "unipolarly" ionized electric fields and the mobilities of ions in air. R. Cochet and R. Reffay. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 14, 1516–18 (*April* 4, 1955) In French.

A brief discussion of measurements of ion mobilities in cylindrical fields using hot probes. In a 40 cm dia. cylinder positive and negative ion mobilities (760 mm Hg pressure, 20°C, relative humidity 40%) of respectively $1{\cdot}61$ and $1{\cdot}56$ cm.sec^{-1}.volt^{-1}.cm^{-1} were found. J. D. CRAGGS

537.562

7153. Energy required to produce one ion pair for several gases. J. Weiss and W. Bernstein. *Phys. Rev.*, **98**, *No.* 6, 1828–31 (*June* 15, 1955).

The absolute values of W, the energy required to produce one ion pair, for electrons have been determined for several gases. A parallel plate extrapolation ionization chamber in conjunction with a ferrous sulphate dosimeter was used. The gases investigated were air, nitrogen, oxygen, carbon dioxide, argon, methane and ethylene; and the absolute values of W were 33·9, 34·8, 30·9, 32·6, 25·5, 26·8 and 26·3 eV, respectively. A.

537.562

7154. Measurement of absorption coefficients for photoionizing radiations in low-pressure gases with a space charge detector. C. D. Maunsell. *Phys. Rev.*, **98**, *No.* 6, 1831–6 (*June* 15, 1955).

A Kingdon cage space-charge detector has been used to measure the production of positive ions in a low-pressure gas due to absorption of photons produced by electron impact excitation in another region of the same gas. Absorption coefficients were measured by changing the source to detector separation. High-purity vacuum techniques were used to avoid contamination of the gas. No ionization was found in hydrogen. For nitrogen the molecular cross-section was $4{\cdot}1 \times 10^{-16}$ cm^2 and for argon the atomic cross-section was $3{\cdot}1 \times 10^{-16}$ cm^2. Tentative suggestions are made as to the processes responsible for these total absorption cross-sections being much larger than the photoionization cross-sections for monochromatic radiations in the ionization continuum region. A.

537.564 : 551.510.535

7155. A note on the diffusion in a gas of electrons from a small source. L. G. H. Huxley and R. W. Crompton. Note in *Proc. Phys. Soc. B*, **68**, *Pt* 6, 381–3 (*June*, 1955).

Gives experimental results to show that the solution of the differential equation for the distribution of the electron concentration in the diffusion apparatus used by the authors [Abstr. 6901 (1953)] is correct. J. DUTTON

537.568

7156. The recombination of electrons and positive ions. M. Bayet and D. Quemada. *J. Phys. Radium*, **16**, *No.* 4, 334–8 (*April*, 1955) In French.

A review paper, with 59 references, which discusses radiative electron–ion recombination, dielectronic recombination and dissociative recombination. J. D. CRAGGS

537.568

7157. Charge distributions of oxygen and neon ions passing through gases. E. L. Hubbard and E. J. Lauer. *Phys. Rev.*, **98**, *No.* 6, 1814–17 (*June* 15, 1955).

Electrons were stripped from accelerated oxygen and neon ions by passing them through a gas. Magnetic deflection was used to select the energy and charge of the incident ions and to determine the distribution of ionic charges in the stripped beam. As the amount of gas that the ions passed through was increased, the peak of the charge distributions first shifted toward higher charge states and then became constant as equilibrium was established between capture and loss of electrons. At equilibrium in argon the charge distributions were bell-shaped, with a width of 1·8 charge states at half maximum. The average ionic charges for 3·3, 6·1 and 8·7 MeV O ions were 3·5, 4·8 and 5·2, respectively, and for 3·1, 7·1 and 10·3 MeV Ne ions 3·3, 4·9 and 6·0, respectively. A.

537.568

7158. Electron capture and loss by ions in gases. R. L. Gluckstern. *Phys. Rev.*, **98**, *No.* 6, 1817–21 (*June* 15, 1955).

Capture and loss cross-sections for ions of intermediate atomic number ($Z_1 = 8$ to 18) passing through low-pressure gases have been calculated. A modified form of Bell's model was used, leading to lower capture cross-sections than the original model.

The resulting equilibrium charge distributions obtained compare favourably with the experimental results of Hubbard and Lauer (preceding abstract). The individual cross-sections were obtained from the observed dependence of the charge distribution on the stripper thickness; these results agree reasonably well with the predictions of the calculations. Capture and loss of two electrons in a single collision may be significant, but the effect on the charge distributions should not be too great. A.

537.568

7159. Cross section for electron capture and loss by 26-MeV nitrogen ions. H. L. Reynolds, L. D. Wyly and A. Zucker. *Phys. Rev.*, **98**, *No.* 6, 1825–7 (*June* 15, 1955).

Electron capture and loss cross-sections were measured for 26 MeV nitrogen ions in Zapon. Charge groups, separated by the fringing magnetic field of the cyclotron, were passed through Zapon foils sufficiently thin so that charge equilibrium was not achieved. The relative intensities of the non-equilibrium charge distributions were analysed to determine the ratios of the cross-sections. It was found that $\sigma_{56}/\sigma_{67} = 2{\cdot}6$, $\sigma_{56}/\sigma_{65} = 3{\cdot}8$ and $\sigma_{67}/\sigma_{76} = 0{\cdot}78$. If it is assumed that the average atom in Zapon has a mass of 14, the cross-sections for electron capture and loss for 26 MeV nitrogen ions are, in cm²/atom: $\sigma_{56} = 7{\cdot}6\times10^{-18}$, $\sigma_{65} = 2{\cdot}0\times10^{-18}$, $\sigma_{67} = 2{\cdot}9\times10^{-18}$, $\sigma_{76} = 3{\cdot}8\times10^{-18}$. Non-equilibrium charge distributions as a function of foil thickness are given for initial beams consisting entirely of any one of the ion groups N^{7+}, N^{6+}, or N^{5+}. A.

537.58 : 535.822.9

7160. Thermionic emission microscopy of metals. I. General. R. D. Heidenreich. *J. appl. Phys.*, **26**, *No.* 6, 757–66 (*June*, 1955).

An electrostatic emission microscope operating with an accelerating voltage of 10–25 kV is briefly described. Factors determining image quality, particularly contrast and resolution, are discussed and the interpretation of images on the basis of the Schottky emission equation is considered. The instrument can be operated at magnifications of 250, 1 000, 2 500 and 4 000× with a resolution consistently better than 1 000 Å. It has been found that the iron group metals can be activated easily using barium formate rather than evaporated Ba or Sr. The level of thermionic emission from such surfaces is determined primarily by the partial pressure of chemical reducing agent at the surface (such as carbon) to reduce BaO to free barium. The effect of various impurities and alloying metals is discussed from the standpoint of interpretation of emission images. The most important single agent for promoting emission from Ni, Cu and Fe, etc., is carbon. Examples of emission images include nickel, stainless steel and plain carbon steel. Complications such as surface roughness are demonstrated with micrographs and the limitations of the technique pointed out. A.

537.581

7161. Work function of cadmium. P. A. Anderson. *Phys. Rev.*, **98**, *No.* 6, 1739–40 (*June* 15, 1955).

The contact difference of potential Cd–Ba is measured by the electron beam and Kelvin methods. These measurements agree within the limits of reproducibility of either method alone and yield a work-function value of 4·08 ± 0·02 eV for the work-function of cadmium films deposited on tantalum. The barium surfaces, formed by redistillation following fractional distillation, show their characteristic constancy and reproducibility to ±0·01 eV. Cadmium retains some gas after exhaustive multiple distillation. Measurements taken immediately after deposition of a Cd film and during its ageing show (1) that freshly deposited Cd films are generally contaminated with gas which distills with the metal; (2) that the adsorbed gas is removed progressively by getter clean-up with an attendant rise in work-function totalling 0·10 eV in extreme cases, and (3) that the work-function thus established is constant and reproducible to 0·03 eV or better. Comparison of these measurements with the author's earlier work on zinc leads to the conclusion that a cadmium surface in equilibrium with the residual gas of a well-gettered tube contains so little adsorbed gas that its final work function can probably be accepted as characteristic of the clean metal. A.

537.583

7162. The effects of barium and oxygen vapours on spectral dependence of thermionic emission from (BaSr)O cathodes. Hibi and Ishikawa. *Vide*, **9**, 121–4 (*July–Sept.*, 1954) In French and English.

Describes experiments undertaken to determine the nature of the centres causing emission peaks for energy levels of 2·3–2·4 and 3·2 eV. A. H. W. Beck

537.583

7163. On the formation of interface resistance in oxide cathodes. A. Lieb. *Vide*, **9**, 166–70 (*July–Sept.*, 1954) In French and German.

The resistance of the interface depends on the working temperature, the current density and the composition of the cathode. Of the materials tested the 4% W–Ni alloy gave much the best results.

A. H. W. Beck

537.583

7164. Experiments bearing on the mobile-donor hypothesis in oxide cathodes. N. S. Nergaard. *Vide*, **9**, 171–6 (*July–Sept.*, 1954) In French and English.

A brief review of the experimental work which led to the donor depletion hypothesis. These are mainly tests on embedded probes, especially in conditions when the surface is being subjected to a current of donor impurities. A. H. W. Beck

537.583

7165. A film of hot cathodes under the electron microscope. E. Brüche. *Vide*, **9**, 177–80 (*July–Sept.*, 1954) In French and German.

At a recent congress a film of the electron microscope images of emitting cathodes, taken by Dr. Brüche between 1932–1936, was shown. This paper is a brief commentary on the film illustrated by a few typical pictures. A. H. W. Beck

537.583 : 621.385.032.21

7166. On the fluctuations in the cathode emission of electronic valves. A. Blanc-Lapierre, G. Goudet and P. Lapostolle. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 13, 1409–11 (*March* 28, 1955) In French.

The consequences of the following hypotheses are

examined: (*a*) Regular electron emission, i.e. times of emission equally spaced. Maxwellian velocity distribution. (*b*) Poisson distribution of times of emission. (*a*) leads to the usual expression for Γ^2, (*b*) to a value twice as great. A. H. W. BECK

537.583 : 621.385.032.216

7167. Improved "impregnated cathode." R. Levi. Letter in *J. appl. Phys.*, **26**, *No.* 5, 639 (*May*, 1955).

Improvements obtained in the characteristics of a dispenser-type cathode [Abstr. 3400 (1953)] are described. C. G. MORGAN

537.583 : 621.385.032.216

7168. On the relations between electron emission, conduction and noise of oxide-coated cathodes. J. Nakai, Y. Inuishi and T.-C. Yang. *J. Phys. Soc. Japan*, **10**, *No.* 6, 437–43 (*June*, 1955).

The Richardson plot of the conduction current showed two straight line regions. The temperature-dependence of the conduction current was found to be the same as that of the emission current, and the density of the former was a few times larger than that of the latter. The noise current accompanying the conduction current showed sharp increase with saturation of the conduction current. This is owing to the disappearance of the space charge in the pore. From these experimental results the pore conduction mechanism of the oxide-coated cathode was ascertained. A.

COSMIC RAYS 537.591

537.591.1

7169. Cosmic rays and air mass effects at Macquarie Island. R. M. Jacklyn. Letter in *Austral. J. Phys.*, **8**, *No.* 1, 190–2 (*March*, 1955).

It is found that here the barometric coefficient for cosmic rays varies according to the type of air mass over the station. Different average values are obtained for the rate of change of height of the assumed production level for mesons with surface pressure for polar air and for temperate air. The effects seem characteristic of the pattern of the weather associated with the passage of cold fronts at Macquarie Island during winter. E. W. KELLERMANN

537.591.1

7170. The knock-on electron method for the determination of the mass of minimum ionization particles. A. De Marco, A. Milone and M. Reinharz. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1041–56 (*June*, 1955) In Italian.

A method has been studied for the determination of the mass of minimum ionization particles in nuclear emulsions, in the case in which a knock-on electron is generated. In using the conservation theorems for energy and momentum a function of the velocity of the particles can be determined which is sensitive to variation of the velocity. Criteria are given for the recognition of the knock-on electrons, and the various errors which influence the measurements of the energy and the angle of emission are examined. The error in the determination of the mass of the incident particle is calculated. An analysis of the distribution of the experimental values shows that the errors calculated according to the criteria given agree quite well with the experimental ones. Taking into account the frequency of these knock-on electrons, the limitations of this method as well as its possible application in the case of single events or in a systematic study of the isotopic composition of the primary cosmic radiation are discussed. A.

537.591.1 : 523.165

Astrophysical notes on the origin of cosmic radiation. *See Abstr.* 6690

537.591.1 : 778.34

7171. Scattering measurements in nuclear emulsions and their application to measuring the charge of primary cosmic ray nuclei. S. Biswas, B. Peters and Rama. *Proc. Indian Acad. Sci. A*, **41**, *No.* 4, 154–84 (*April*, 1955).

Small local dislocations in processed emulsions give rise to spurious scattering whose effect on tracks is indistinguishable from the multiple scattering produced by Coulomb interaction. Because of this effect the atomic number of fast primary cosmic-ray nuclei will be underestimated in more than 50% of the cases in experiments where multiple scattering of tracks and ionization measurements are employed for charge determination. The spurious scattering was investigated by measuring the track contours of 100 very long tracks due to energetic primary particles; the effect was present in comparable strength in all plates and all types of emulsions which have been investigated. It is too small to affect measurements on medium-energy particle tracks (protons with energy below 600 MeV and heavy nuclei with energy below 300 MeV/nucleon). It dominates, however, other sources of error and noise for tracks of energetic particles although it does not preclude occasional observations of very low scattering values. New methods for measuring various forms of noise have also been developed in the course of this work and the noise level for scattering measurements has been reduced below previously accepted values. Spurious scattering is presumably largely responsible for the discrepancies which appear when one compares the primary charge and energy spectra derived from experiments involving scattering measurements with the corresponding spectra derived from numerous other experiments which employ different techniques. If the experiments based on scattering measurements are omitted, the remaining evidence strongly favours a spectrum in which the energy per nucleon is nearly independent of atomic number for all primaries. It also favours a charge distribution which has a pronounced minimum for charges $3 \leqslant Z \leqslant 5$ and, therefore, yields a fairly low upper limit for the amount of interstellar matter traversed by primary cosmic-ray nuclei. A.

537.591.5

7172. Solar flare and magnetic storm effects in cosmic-ray intensity near the geomagnetic N pole. J. W. Graham and S. E. Forbush. *Phys. Rev.*, **98**, *No.* 5, 1348–9 (*June* 1, 1955).

During the solar flare of July 25, 1946, an increase of 14% in hourly mean values of cosmic-ray ionization was observed at Thule, Greenland (geomagnetic

latititude 88° N), at sea level, under 11 cm Pb. The increase and its gradual diminution toward normal during the 24 hr after the flare was statistically indistinguishable from results at Godhavn, Greenland (geomagnetic latitude 80° N). The subsequent decrease during the magnetic storm, which began 27 hr after the flare, was also in agreement at Thule and Godhavn. If the increase were due to charged particles from the sun, these observations at Thule emphasize the fact that the trajectories involved are markedly affected by factors other than the earth's magnetic dipole. A.

537.591.5 : 523.74

Association of a "unipolar" magnetic region on the sun with changes of primary cosmic-ray intensity. *See Abstr.* 6699

537.591.8

7173. Angular distribution in cosmic ray stars. E. LOHRMANN. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1126–40 (*June*, 1955).

The angular distribution of star-producing particles and their secondaries was measured under absorbers of Fe, Sn and C at altitudes of 2960 m (Zugspitze) and 420 m (Weissenau). The angular distribution of ionizing star producing particles can approximately be represented by a $\cos^6\theta$ law at 2960 m and by $\cos^{5,7}\theta$ at 420 m. With increasing energy of the particles the distribution appears to be stronger collimated towards the vertical. The angular distribution of grey tracks around the direction of the star-producing particle agrees with results of the Bristol Group for stratosphere altitudes, suggesting the distribution to be independent of the energy of the star-producing particle. With increasing energy of the secondaries an increasing collimation of the angular distribution is observed. The angular distribution of grey tracks relative to the vertical is given for neutron- and for proton-induced stars respectively. An attempt is made to derive the angular distribution of the neutral star-producing component leading to a $\cos^n\theta$ law with $1 < n < 4$. A.

537.591.8

7174. On the topographic distribution of cosmic ray stars in nuclear emulsion. E. LOHRMANN. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1141–5 (*June*, 1955).

Cosmic-ray stars are found to have a completely random distribution at distances $<500\,\mu$ in nuclear research emulsions, which had been exposed under different absorbers at mountain altitudes. This random distribution is not influenced by transition effects of the star frequency. A.

MAGNETISM 538

538.082/.083

7175. Methods of measuring strong magnetic fields. J. L. SYMONDS. *Rep. Progr. Phys.*, **18**, 83–126 (1955).

Descriptions which are briefly theoretical and essentially practical are given of a number of the techniques of magnetic field measurement, used or developed in the period of about twenty years since the last review of the subject. Particular attention is given to the application of the phenomenon of magnetic resonance while other subjects discussed are magneto-resistance, Hall effect, peaking strips, the generator principle and various fluxmeters. The uses which are made of the force exerted on a current-carrying conductor in a magnetic field are given though some of these are not, strictly speaking, field measurements. The measurement of the position of the magnetic median plane of a magnet is discussed. The last paragraphs are devoted to a description of a few methods which do not find very wide application. A list of about 150 references is appended. These are classified in groups under the heading of each particular method. A.

538.082 : 537.311.33 : 621.315.59 : 621.317.444

7176. Indium antimonide as a fluxmeter material. E. W. SAKER, F. A. CUNNEL AND J. T. EDMOND. *Brit. J. appl. Phys.*, **6**, *No.* 6, 217–20 (*June*, 1955).

General principles in the measurement of magnetic fields by use of the Hall effect are considered, and it is shown that the efficiency of Hall generator devices is proportional to the square of the carrier mobility in the material used. Indium antimonide, a semiconductor with a very high carrier mobility, is therefore very useful for such a purpose. The construction of fluxmeter probe units using indium antimonide is described. Sensitivity and linearity are discussed, and methods are given for temperature compensation. A.

538.083.9 : 621.317.42

7177. Measurement of magnetic field gradients. J. F. FRAZER, J. A. HOFMANN, M. S. LIVINGSTON AND A. M. VASH. *Rev. sci. Instrum.*, **26**, *No.* 5, 475–6 (*May*, 1955).

A simple instrument for measuring magnetic field gradients with one-half % accuracy is described, consisting of a small search coil vibrated at 100 c/s by a loudspeaker. The application of this instrument to field gradient measurements on a magnet with hyperbolic pole pieces is described, together with some considerations on constant gradient shimming. A.

538.11

7178. Magnetic resonance for arbitrary field strengths. R. K. WANGSNESS. *Phys. Rev.*, **98**, *No.* 4, 927–33 (*May* 15, 1955).

Starting from a microscopic viewpoint, the steady-state value of the magnetization of a system of moments has been calculated semiclassically and quantum mechanically when the external field has a circularly polarized component perpendicular to the constant component. It is assumed that the only other processes which can change the orientation of the individual moments are strong collisions, and that their average tendency is to produce equilibrium with respect to the instantaneous value of the field. The solutions thus obtained predict a non-zero absorption in zero constant field, and that there is no dependence of g-values on frequency. Further properties of the solutions are discussed. It is also shown that the solutions for the circularly polarized case, as well as Garstens' expression for the absorption coefficient for the linearly polarized case, can be obtained as steady-state solutions of the macroscopic equation $d\mathbf{M}/dt =$

$\gamma\mathbf{M}\times\mathbf{H} + \tau^{-1}[\chi_0\mathbf{H} - \mathbf{M}]$. This equation is a special case of an equation in which longitudinal relaxation is assumed to be along and transverse relaxation perpendicular to the instantaneous field. The relation of these results to the question of the general validity of this modified form of Bloch's equation is discussed. A.

538.114

7179. Atomic magnetic moments of ferromagnetics. S. V. Vonsovskiĭ and K. B. Vlasov. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 327–40 (1953) In Russian.

Atomic magnetic moments are calculated using a model based on a theory of interacting external 4*s*- and internal 3*d*-electrons in the crystal lattice. One consequence of this theory is that such moments have non-integral values. Discussing pure metals the authors assume the total free energy of the electrons to be the sum of the free energies of the internal and external electrons and expressions are derived for the atomic magnetic moment at temperature T and at very low temperatures. Using a general wave-function derived by Vonsovskiĭ [*Zh. éksper. teor. Fiz.*, **16**, 981 (1946)] and the Smirnov quantum theory of alloys, the authors go on to determine for disordered alloys the equilibrium values of magnetization due to *s*- and *d*-electrons and hence to derive an expression for χ (alloy). This is an approximately parabolic relation with respect to concentration. The authors also indicate how to work out the dependence of the Curie point on concentration. Calculation of the energy spectrum of an external electron taking account of *s*–*d* exchange interaction for an ordered alloy shows this has the form of two non-overlapping bands. Unlike Smirnov the authors find that in a ferromagnetic alloy the breadth of these energy bands and their separation depend on the magnitude of *d*-electron magnetization and the orientation of the spin of an *s*-electron relative to this magnetization. Analysis gives the same expression for atomic magnetic moment as for disordered alloys. Qualitative agreement is stated to be found between experimental results for Fe–Ni alloys and the calculated dependence upon concentration and degree of ordered arrangement of the alloy—roughly parabolic in form with maximum at stoichiometrical composition. [The value of the paper would be much enhanced by an additional section giving a detailed comparison of theoretical and experimental results.] C. R. S. Manders

538.221

7180. The relaxation process in ferromagnetic resonance absorption. T. Kasuya. Letter in *Progr. theor. Phys.*, **12**, *No.* 6, 802–3 (*Dec.*, 1954).

A theoretical treatment of relaxation times for non-metallic ferromagnetics, e.g. ferrites, indicate that three spin wave collisions are important. These are permitted as a result of lattice imperfections and $1/\tau \sim 10^8\,\mathrm{sec}^{-1}$ and should be proportional to T.

D. H. Whiffen

538.221

7181. The relaxation process in ferromagnetic resonance absorption. T. Kasuya. Letter in *Progr. theor. Phys.*, **12**, *No.* 6, 803–5 (*Dec.*, 1954).

See preceding abstract. A similar treatment when conduction electrons are present, indicates *d* electron spin/conduction electron orbital interaction to be the controlling feature governing the relaxation time of 10^{-10} sec which should be independent of T.

D. H. Whiffen

538.221

7182. Motion of individual domain walls in a nickel–iron ferrite. Erratum. J. K. Galt. *Bell Syst. tech. J.*, **34**, *No.* 2, 439–41 (*March*, 1955).

See Abstr. 1049 (1955). Gives an alternative derivation of the relation for the velocity of a 180° domain wall on the basis of Néel's theory of magnetic viscosity. The relation is closely similar to relation (38) of the previous paper. E. P. Wohlfarth

538.221

7183. The influence of temperature on magnetic viscosity. J. H. Phillips, J. C. Woolley and R. Street. *Proc. Phys. Soc. B*, **68**, *Pt* 6, 345–52 (*June*, 1955).

Measurements have been made to demonstrate the effect of temperature on irreversible magnetic viscosity in different types of precipitation alloys: Pt–Co, Ni_3Au and Alnico in an undeveloped state. In this type of alloy, the intensity of magnetization varies as a function of time according to the law $I = S_0 \ln t +$ const. On the activation energy model of irreversible magnetic viscosity if ΔE is the change in activation energy produced by a small change in applied field ΔH, $\Delta E = q\Delta H$. For the Alnico and Ni_3Au specimens the two magnetic viscosity parameters S_0 and kT/q are approximately linearly related to temperature. For Pt–Co the viscosity parameters and the coercivity decrease rapidly with increasing temperature. The results are interpreted in terms of Néel's disperse field theory of magnetization with the additional assumption that strains set up between coherent precipitate and matrix are responsible for the production of the disperse fields. It is predicted from the observations of magnetic viscosity that in Pt–Co the disregistry between precipitate and matrix decreases on increasing the temperature. This has been verified by measurements of the differential thermal expansion between the material of precipitate and the matrix by X-ray methods. A.

538.221 : 537.312.8 : 548.7

7184. Longitudinal magneto-resistance effect of narrow single crystal strips of iron. I. K. Kuwahara. *J. Sci. Hiroshima Univ. A*, **18**, *No.* 1, 87–94 (*June*, 1954).

Describes measurements of the magnetic resistance change of long, narrow iron single-crystal specimens, the [100] axis lying parallel to their lengths and the (100) or (110) crystal planes lying parallel to the surface; specimens with other orientations were also investigated. The effect was found to depend markedly on the orientation. E. P. Wohlfarth

538.221 : 539.185

Multiple scattering of slow neutrons by flat specimens and magnetic scattering by zinc ferrite. *See Abstr.* 7403

538.222/.224

7185. Order-disordered transformation and magnetic susceptibility of Mg–Cd alloys. N. Miyata. *Sci. Rep. Yokohama Nat. Univ. I*, *No.* 1, 15–26 (*March*, 1952).

Reports results of susceptibility measurements over

the whole composition range and at temperatures between room temp. and 350°C. At room temp. the alloys between pure Cd and 60% Mg (atomic) are diamagnetic, and those between 60% Mg and pure Mg paramagnetic. In the disordered state the susceptibilities are temperature independent and vary linearly with the atomic concentration of Mg. The susceptibilities are numerically larger in the ordered than in the disordered state. Comparison is made with results of electrical resistance measurements.

E. P. WOHLFARTH

538.222

7186. Paramagnetic susceptibility of solid oxygen. E. KANDA, T. HASEDA AND A. ÔTSUBO. *Sci. Rep. Res. Insts Tohoku Univ. A*, **7**, *No.* 1, 1–5 (*Feb.*, 1955).

The susceptibility solid oxygen was investigated between 2 and 77°K. The magnetic transitions occur at 23·7° and 43·7°K, which agree well with results from thermal investigation. From the large negative Weiss constant in the liquid and the figure in the β-phase, it may be concluded that oxygen is antiferromagnetic at low temperatures. Some theoretical consideration was attempted, but it was found difficult on account of the present imperfect knowledge about the crystal structure of oxygen and the lack of the calculation about the $2p$–$2p$ interaction in large distances. A.

538.222

7187. Magnetic investigations on two alloys of the Au–Mn system. A. GIANSOLDATI. Letter in *J. Phys. Radium*, **16**, *No.* 4, 342–3 (*April*, 1955) In French.

Reports results of susceptibility measurements between room temp. and 1100°K for the alloys Au_3Mn and AuMn. For Au_3Mn a sudden change of susceptibility was observed at 920°K, accompanied by temperature hysteresis. For AuMn a very sharp susceptibility maximum was observed at 500°K, indicating this alloy to be antiferromagnetic.

E. P. WOHLFARTH

538.222

7188. Paramagnetic resonance of charcoals. Detection of a free radical unstable in air. J. UEBERSFELD AND E. ERB. Letter in *J. Phys. Radium*, **16**, *No.* 4, 340 (*April*, 1955) In French.

Sucrose carbonized up to 850°C in N_2 gives a large free radical electron resonance (10^{20} radicals/g), $g = 2{\cdot}002$, width 2·1 gauss, which disappears with O_2 in 10–20 sec, but reappears on evacuation for several days at 25°C and more rapidly at higher temperature. Carbonization below 650°C gives in addition a free radical stable in air and carbonization above 900°C gives no free radicals. D. H. WHIFFEN

538.222

7189. Paramagnetic resonance of X-rayed Teflon. E. E. SCHNEIDER. Letter in *J. chem. Phys.*, **23**, *No.* 5, 978–9 (*May*, 1955).

Irradiation of Teflon with X-rays gave a broad triplet peak which is interpreted as electron resonance of terminal $-CF_2\cdot$ groups with appreciable coupling to the F spins. Each peak is 23 gauss wide, $g = 2{\cdot}021$ and the intensity corresponds to 10^{17} spins/cm^3 after a dose of 5×10^5 r. D. H. WHIFFEN

538.222 : 541.12

7190. Detection of free radicals in polyacrylonitrile by paramagnetic resonance. C. H. BAMFORD, A. D. JENKINS, D. J. E. INGRAM AND M. C. R. SYMONS Letter in *Nature* [*London*] **175**, 894–5 (*May* 21, 1955).

The product from acrylonitrile 20% polymerized photochemically with 10% di-tert-butyl peroxide was shown to contain 10^{17} unpaired electrons per ml, which is 2% of the total radicals generated. The paramagnetic electron resonance signal, $g = 2{\cdot}00$, was 20 gauss wide and disappeared in 30 min with O_2 or air. D. H. WHIFFEN

538.222 : 548.7

7191. Oscillatory Hall effect, magnetoresistance, and magnetic susceptibility of a graphite single crystal. T. G. BERLINCOURT AND M. C. STEELE. *Phys. Rev.*, **98**, *No.* 4, 956–61 (*May* 15, 1955).

The Hall coefficient, magnetoresistance, and magnetic susceptibility of a graphite single crystal have been measured at liquid helium temperatures and in magnetic fields up to 25 kilogauss. All three phenomena are periodic functions of reciprocal field and exhibit the same period for like orientations of the crystal axes with respect to the magnetic field. The phases, however, are different. Where possible, experiment and theory have been compared. A.

538.224

7192. Temperature dependence of [the] magnetic anisotropy of Cd_3Mg. N. MIYATA. *Sci. Rep. Yokohama Nat. Univ. I*, *No.* 3, 19 (*March*, 1954).

Reports results of measurements of the two principal susceptibilities of a single crystal specimen between room temp. and 200°C. An order-disorder transformation was found to occur at 100°C.

E. P. WOHLFARTH

538.23

7193. A new method of determining the hysteresis loop of a ferromagnetic body subjected to an alternating magnetic field. I. Theory. J. GARCIA SANTESMASES AND M. ALIQUE PAGE. *An. Real. Soc. Españ. Fis. Quim.*, **51(A)** *No.* 3–4, 67–76 (*March–April*, 1955) In Spanish.

The alternating current I is passed in series through the primary of a mutual inductor M and the magnetizing winding on the specimen, resulting in an instantaneous e.m.f. e_1 in a secondary winding on the specimen and e_2 in the secondary of M. The average values, E_{1m} and E_{2m}, of e_1 and e_2 over a half-period of I then measure the flux-change and field-change over that half-period. By varying the phase of the half-period, the hysteresis loop can be determined point by point. The present Pt is mainly a theoretical analysis of the accuracy and zero-stability of a proposed double-pentode balanced gating circuit for selecting the desired half-period. F. F. ROBERTS

538.245 : 538.652

7194. Quantum theory of the magnetostriction of ferromagnetic monocrystals. A. A. GUSEV. *Dokl. Akad. Nauk SSSR*, **98**, *No.* 5, 749–52 (1954) In Russian.

A systematic quantum-mechanical consideration of the electron system in a spontaneously deformed ferromagnetic monocrystal furnishes an explanation of the

phenomenon of magnetostriction and shows its relationship with the magnetic interaction of the electrons. The theory yields the temperature relation of the magnetostriction constants at low temperatures for hexagonal and cubic crystals which must show analogies with the anisotropy constants, as suggested by the character of the low-temperature energy spectrum. ELECTRICAL RESEARCH ASSOCIATION

538.245 : 539.23

7195. Magnetization reversal in thin films. R. L. CONGER. *Phys. Rev.*, **98**, *No.* 6, 1752–4 (*June* 15, 1955).

An experiment has been performed which indicates that magnetization reversal in evaporated films of 80% Ni, 20% Fe, 2×10^{-5} cm thick takes place by domain rotation rather than by the motion of 180° domain walls. A.

538.245 : 539.374

7196. Influence of plastic deformation on the Barkhausen effect. K. WOTRUBA. Letter in *Czech. J. Phys.*, **4**, *No.* 3, 375–7 (*Sept.*, 1954) In Russian.

The number and size of discontinuities were measured on mu-metal plates subjected to various degrees of cold rolling (down to 41% of the original thickness), (*a*) with, and (*b*) without subsequent annealing. The effect was over 10 times more pronounced in specimens (*b*) than in specimens (*a*). 7 refs. A. GELBTUCH

538.245 : 539.374

Magnetic investigations on internal strains in plastically stretched carbon steel. *See Abstr.* 7434

538.245.08

7197. On the quantitative measurement of Barkhausen discontinuities. K. WOTRUBA. Letter in *Czech. J. Phys.*, **4**, *No.* 3, 377–9 (*Sept.*, 1954) In Russian.

To compare results of investigations carried out with sinusoidal and rectangular wave current, it is necessary to know the relation between their peak values. It is shown that calibration with sinusoidal wave current is equivalent to calibration with rectangular wave current of the same peak value. 4 refs. A. GELBTUCH

538.247

7198. Influence of a circular field on the form of the longitudinal magnetization curve. R. E. ERSHOV. *Zh. tekh. Fiz.*, **24**, *No.* 8, 1508–12 (1954) In Russian.

538.247

7199. Investigation of the hysteresis of the ballistic demagnetization coefficient. A. P. LYUSTROVA AND V. A. LIPATOVA. *Zh. tekh. Fiz.*, **24**, *No.* 8, 1513–19 (1954) In Russian.

538.27

7200. Investigation of the temperature dependence of magnetic susceptibility of $MnCl_2$ below 4·2°K. M. O. KOSTRYUKOVA. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11) 655–6 (1954) In Russian.

The susceptibility shows a flat maximum at about 1·8°K, confirming a transition to antiferromagnetism suggested by a previously found specific heat anomaly at 1·96°K. D. SHOENBERG

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

7201. A postulational approach to electromagnetism. P. MOON AND D. E. SPENCER. *J. Franklin Inst.*, **259**, 293–305 (*April*, 1955).

Charge and current are defined operationally and intensities are defined in terms of potentials. Retarded fields, charge conservation and the force on a moving charge are postulated. It is claimed that the system of postulates and definitions provides a logical basis for Maxwell's equations. A similar and simpler system is set up for the authors' "new electrodynamics" [Abstr. 2896 (1955)]. R. A. NEWING

538.3

7202. The hypothesis of the polarization of the vacuum in classical electromagnetism. E. DURAND. *J. Phys. Radium*, **16**, *No.* 4, 262–70 (*April*, 1955) In French.

An extension of previous work [Abstr. 9404 (1954)]. The electric and magnetic polarization vectors are defined for the vacuum and, similarly, for fixed or moving point charges, linear currents, etc., and their physical interpretation is discussed. G. FIELD

538.3 : 530.12

7203. On Langevin's formulation of the concepts and laws of the electromagnetic field. R. DEBEVER AND J. GÉHÉNIAU. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41**, *No.* 3, 346–55 (1955) In French.

Two differential forms are treated, each of which represents the electromagnetic field in a relativistically covariant way. The first, combining electric field and magnetic induction, is related to the action of the field on a moving point charge; the second, combining magnetic field and electric induction, is related to the amount of electricity induced on a surface. Some special cases are examined. J. S. BELL

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

7204. The velocity of the wave front in nonlinear electrodynamics. L. G. YAKOVLEV. *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 246–8 (1955) In Russian.

The author concludes from his analysis that when the conditions of the propagation of electromagnetic disturbances deviate from the linear conditions, the velocity of the wave front, defined as the velocity of a surface at which the field is slightly discontinuous, may, at the appropriate choice of the Lagrange function, prove to be higher than the velocity of light *in vacuo*, as a theoretical possibility, but at the same time he leaves open the question of whether this theoretical possibility can be experimentally detected. The slight discontinuities in the field are introduced by using the Lagrange function from which the standard e.m. equations can be derived for a general case and assuming that at slight deviations from linearity the fields will still be approximately additive. The work is largely based on previous investigations by D. I. Blokhintsev and V. V. Orlov [Abstr. 5292 (1953),

1062 (1955)], M. S. Svirskiĭ [*Vestnik M.G.U.*, **3**, 43 (1951)] and A. Sommerfeld [*Ann. Phys.* [*Leipzig*] **44**, 177 (1914)]. N. S. JAPOLSKY

538.56 : 532.5 : 523.75

Magneto-hydrodynamic waves and solar prominences. *See Abstr.* 6702

538.561

7205. Longitudinal plasma oscillations. I. A. A. LUCHINA. *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 17–27 (1955) In Russian.

The problem of the propagation of longitudinal oscillations in a plasma is solved for given boundary conditions. Whilst in the conventional treatment of this problem only the electron movements are considered, the author also considers ion movements. The treatment is based on the kinetic equations for electrons and ions, and the interactions of the charged particles are taken into account by using Vlasov's variant of the method of the self-consistent field. Elastic collisions of charged with neutral particles are allowed for by Boltzmann's integral term. As a zero approximation of the distribution of the ions (undisturbed state) a Maxwell distribution is assumed. The "dispersion" equations obtained represent an asymptotic solution for the longitudinal electric field in a plasma set up by periodic disturbances at the boundary. They differ from Landau's solution of the problem of longitudinal plasma waves by terms involving ions and the collisions of charged and neutral particles. B. F. KRAUS

538.561 : 523.877

7206. Plasma oscillations in an external magnetic field. R. LÜST. *Z. Astrophys.*, **37**, *No.* 1, 67–71 (1955) In German.

The propagation of a plane wave normal to an external magnetic field is examined. A transverse wave with the direction of oscillation parallel to the magnetic field is not influenced by it. A wave with the plane of oscillation normal to the external field is neither purely transverse nor purely longitudinal. The transverse component gives a non-vanishing Poynting vector, in contrast to pure plasma oscillation, and the emission of radio radiation can occur.

M. W. OVENDEN

538.565 : 535.22

7207. The velocity of propagation of electromagnetic waves. J. T. HENDERSON AND A. G. MUNGALL. *Canad. J. Phys.*, **33**, *No.* 6, 265–74 (*June*, 1955).

Measurements using a coaxial cavity resonator have been carried out at a frequency of 400 Mc/s, which is close to that employed for geodetic surveying in Canada. The results were consistent, giving a value for c of 299 780 km/s. This value is probably low because the effect of discontinuities at the cavity junctions cannot be computed with certainty. A.

538.566

7208. The energy-impulse tensor of radiation in dielectrics. G. MARX AND K. NAGY. Note in *Acta phys. Hungar.*, **4**, *No.* 3, 297–300 (1955) In German.

A completely consistent theory, based on Abraham's tensor of electromagnetic radiation is developed.

J. H. MASON

538.566 : 530.145

Diffraction of the ψ_n waves of the Dirac electron by a semi-infinite plane and a slit. *See Abstr.* 6749

538.566 : 535.421

On the diffraction of a plane wave by an infinite plane grating. *See Abstr.* 6963

538.566 : 621.373.1.029.65

7209. On the generation of radio waves in the millimetre region by passing an electron cloud through a retarding medium. G. A. ASKAR'YAN. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 761 (1954) In Russian.

A method is proposed which, it is stated, is more useful than those described up till now. If an electron cloud is passed through a series of equispaced retarding dielectric layers, coherent radiation is produced. For an electric field of 2 MV/cm, 5×10^7 electrons in the cloud, a beam current of 10 mA, about 0·1 W of power should be produced in the region of 1 mm.

S. C. DUNN

538.566

7210. Study of the electromagnetic field in the neighbourhood of a reflecting surface. M. BOUIX. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1763–5 (*May* 2, 1955) In French.

A generalized solution of the problem of reflection of a plane wave from an arbitrary surface. The co-ordinate system used, has for axes, the direction normal to the surface, and two orthogonal directions in the surface. G. D. SIMS

538.566

7211. On a waveguide with a conducting screen. P. TABELLINI. *Atti Sem. Mat. Fis. Univ. Modena*, 6 (1951–52); 87–97 (1953) In Italian.

Monochromatic waves are propagated in the guide which is circular and carries a coaxial screen. The modes of propagation are studied by solving Maxwell's equations. The only symmetrical modes are found to be transverse electric or transverse magnetic, and the unsymmetrical modes are generally hybrid.

MATHEMATICAL REVIEWS

538.566

7212. Propagation of electromagnetic waves in an anisotropic gyromagnetic medium contained in a rectangular waveguide. A. CHEVALIER, T. KAHAN AND E. POLACCO. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1323–4 (*March* 21, 1955) In French.

The equations of Polder [Abstr. 1993 (1949)] for the magnetic induction substituted into Maxwell's equations lead to a fourth-order partial differential equation for the component of the electric field in the propagation direction. This equation is solved by means of separation of variables and the result is presented in closed form without further discussion of the propagation properties of the medium. [The presentation suffers from brevity: the definition of several symbols is omitted.] H. MOTZ

538.566

7213. Simultaneous partial absorption, reflection, and transmission of a non-uniform plane wave by a thin metallic sheet (or film). M. GOURCEAUX. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1871–2 (*May* 9, 1955) In French.

An extension of the results of a previous note [Abstr. 5535 (1955)] to cover the case of waves of the

type found in waveguides. A maximum absorption in the film occurs at a critical thickness as before. It can be shown that if n foils are positioned in a guide at half guide-wavelength spacings, the absorption is $n \times$ that for a single foil. G. D. SIMS

538.566.2 : 621.396.11

7214. Long distance v.h.f. fields. I. Partial reflection from a standard atmosphere. F. H. NORTHOVER. *Canad. J. Phys.*, **33**, *No.* 5, 241–56 (*May*, 1955).

Reliable propagation of v.h.f. waves and microwaves from high power transmitters to distances of several hundred miles beyond optical range has been demonstrated by an ever-increasing number of experiments during the last ten years. The fields which have been observed have consistently been many times greater than the field strengths predicted by the "effective radius" theory. The theory that the phenomenon can be explained solely in terms of "partial internal reflection" from elementary layers of a dielectric distribution where the rate of decrease of $(\mu - 1)$ with height is everywhere continuous and of the same order of magnitude as in a "standard" atmosphere is carefully examined and found to be untenable. A.

538.566.2 : 621.396.11

7215. Long distance v.h.f. fields. II. Refractivity profiles containing "sharp layers." F. H. NORTHOVER. *Canad. J. Phys.*, **33**, *No.* 6, 316–46 (*June*, 1955).

The general solution developed in Pt I is applied to the case in which the refractivity profile contains sharp layers (i.e. local regions where μ and $d\mu/dh$ change very rapidly compared with their rate of variation in a "standard" type atmosphere). It is found that such layers, when well developed, can cause distance fields of the order of magnitude of those which have been observed, but present experimental evidence indicates that scattering from atmospheric turbulence is usually the important factor. A physical interpretation of the field-formation below the elevated layer is attempted. A.

538.566.2 : 621.396.11

7216. Long-distance v.h.f. fields. III. The case of two elevated layers. F. H. NORTHOVER. *Canad. J. Phys.*, **33**, *No.* 6, 347–9 (*June*, 1955).

The general theory developed in I and II is applied to derive an equation for the eigenvalues of the propagation for the case of two sharp elevated layers. This equation is very briefly discussed and some special cases noted. A.

538.566.2

7217. Doppler spectrum of sea echo at 13·56 Mc/s. D. D. CROMBIE. Letter in *Nature* [*London*] **175**, 681–2 (*April* 16, 1955).

The Doppler frequency shift of radiowaves at 13·56 Mc/s reflected from the sea is found experimetally to have its main component at 0·38 Mc/s irrespective of wind conditions and the state of the sea. The smaller maxima observed suggest that sea waves exist in trains of about 6 crests, and act as diffraction gratings with small numbers of lines. Extension of this principle by using other radio frequencies leads to a sea wave spectrometer.

N. CORCORAN

538.566.3 : 551.510.535

7218. Ionospheric self-interaction of radio waves at vertical incidence. G. J. AITCHISON AND G. L. GOODWIN. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 4, 722–5 (*April*, 1955).

Account of measurements made at night at Adelaide during May–Oct., 1954, of the percentage modulation depth of sky-wave signals, calibrated with respect to the ground-wave. Results show that near the gyro-frequency the modulation depths of both E- and F-reflected waves were significantly less than that of the ground-wave, the reduction being greater for F-reflection. No reduction in modulation depth occurred at a frequency remote from the gyro-frequency. It is suggested that near the gyro-frequency the x-component is strongly absorbed in the E-layer and the absorption coefficient of the ionosphere varies at the modulation frequency causing a change in modulation depth of the o-component.

G. M. BROWN

538.566.3 : 551.510.535

7219. Note on experiments of the ionospheric interaction of radiowaves. M. CUTOLO. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 4, 726–32 (*April*, 1955) In Italian.

Reply to criticism by Boella [Abstr. 9416 (1954)] of author's earlier work. Recent Indian [Abstr. 6161 (1954)] and Australian (preceding abstract) experiments are quoted to support author's argument affirming the existence of self-demodulation and its use for determining the Earth's magnetic field in the E-layer. It is shown that the masking effect of selective fading may be avoided. J. J. PHIPPS

538.566.3 : 621.396.11

7220. Measurements of limiting polarization of radio waves reflected from the F-layer. B. LANDMARK. *J. atmos. terrest. Phys.*, **6**, *No.* 5, 284–6 (*May*, 1955).

Polarization measurements have been made at Kjeller on F-echoes close to the critical frequency. The values for the axis ratio of the ellipse of polarization found were between 0·8 and 1·0. This is in contrast to recent measurements reported, where values of the axis ratio of 0·1 to 0·2 have often been observed. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 548.7

7221. Quantum theory of solids. R. E. PEIERLS. *London: Oxford University Press* (1955) 238 *pp.* + 17 *text-figures.* [*The international series of monographs on physics.*]

"Develops the subject from the basic principles of quantum mechanics. The emphasis is on a single statement of the ideas underlying the various approximations that have to be used, and care is taken to separate sound arguments from conjecture. The treatment covers the electron theory of metals as well as the dynamics of crystals, including the author's previously unpublished work on the thermal conductivity of crystals."

539.11

7222. On some properties of a slightly non-ideal electron gas. G. E. Zil'berman. *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11) 549–56 (1954) In Russian.

Treats the conditions under which the interactions of the electrons in a crystal may be treated as perturbations. The free energy at absolute zero is then calculated, including a magnetic field, and the susceptibility evaluated. Lastly, the dispersion law near the Fermi level is obtained. J. M. RADCLIFFE

539.11

7223. The Fermi distribution at absolute zero, taking account of the interaction of electrons with the zero-point vibrations of the lattice. V. L. Bonch-Bruevich. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 121–2 (1955) In Russian.

Computes an approximation to the momentum distribution in a gas of electrons interacting with the acoustic modes of lattice vibration. The Green's function for an electron is calculated by solving the integral equation obtained by expanding the mass operator in powers of the coupling constant g, and retaining terms to $0(g^2)$. J. M. RADCLIFFE

539.11

7224. The mean free path of a non-localized exciton in an atomic crystal. A. I. Ansel'm and Yu. A. Firsov. *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 151–9 (1955) In Russian.

The mean free path of an exciton is calculated by using the Bardeen–Shockley deformation potential to describe its interaction with the acoustic modes of lattice vibration. J. M. RADCLIFFE

539.11

7225. Dispersion formulae of the quantum optics of metals in the many-electron theory. A. V. Sokolov. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 341–51 (1953) In Russian.

Without recourse to any model, the general dispersion formulae of the quantum optics of metals are derived taking into account the interaction of the ensemble of electrons. S. DEDIJER

539.11

7226. Solution of the Hartree–Fock–Slater equations for silicon crystal by the method of orthogonalized plane waves. T. O. Woodruff. *Phys. Rev.*, **98**, *No.* 6, 1741–2 (*June* 15, 1955).

The orthogonalized plane wave (OPW) method is used to compute estimates of the energy eigenvalues associated with states for which $\mathbf{k} = 0$ in the valence and conduction bands of a perfect silicon crystal; these estimates are tabulated. A simple method for determining an approximate crystal potential is described. The importance of the requirement that exactly the same crystal potential be used to determine the crystal core states as is used in the OPW determination of the higher states is emphasized. A.

539.11

7227. Nuclear spin relaxation in alkali metals. D. F. Holcomb and R. E. Norberg. *Phys. Rev.*, **98**, *No.* 4, 1074–91 (*May* 15, 1955).

Nuclear magnetic resonance measurements have been made in metallic lithium, sodium and rubidium, using pulsed radio-frequency power. The experimental data are values of T_1, the spin-lattice relaxation time, and of T_2, the inverse line width or spin-spin relaxation time. Measurements were made at several Larmor frequencies and at temperatures between −65°C and 250°C. Over a considerable temperature range, T_1 is found to be primarily determined by interaction with the conduction electrons. The magnitudes of T_1 agree fairly well with the Koringa theory in all three metals. The lithium data in particular indicate that $P_f/P_a \simeq 0{\cdot}6$. In lithium and sodium a dependence of T_1 on the resonance frequency is observed, which cannot be explained on the basis of the Korringa theory. Information about the atomic self-diffusion process is also obtained. Portions of the T_1 and T_2 data are interpreted using the theory of Bloembergen, Purcell and Pound. In addition, some of the T_1 data are interpreted in terms of the lattice diffusion theory of Torrey. These analyses yield values for D, the coefficient of self diffusion, of $0{\cdot}24^{+0{\cdot}17}_{-0{\cdot}10} \times \exp(-13\,200 \pm 400/RT)\text{cm}^2/\text{sec}$ in lithium and $0{\cdot}20^{+0{\cdot}56}_{-0{\cdot}15} \times \exp(-10\,000 \pm 600/RT)$ cm^2/sec in sodium. Although there is some ambiguity in the interpretation of the rubidium data, they indicate $D \simeq 0{\cdot}23 \exp(-9\,400/RT)\,\text{cm}^2/\text{sec}$. Unusual broadenings of the resonance lines are observed at the melting points in all three metals. These broadenings are not presently understood, but some features of the data can be correlated with a mechanism involving magnetic local fields which arise from lattice imperfections. A.

539.11 : 537.311.31 : 537.531 : 535.343

7228. Brillouin zones, electrical conductivity of metals and X-ray K absorption spectra. C. Kurylenko. *Cahiers de Phys.*, *No.* 54, 1–36 (*Feb.*, 1955) In French.

The theory of electrons in crystal lattices is summarized, and applied to the fine structure of the X-ray absorption edge. A linear relation is found between the logarithm of the electrical conductivity and $[(V_0 - \phi) - \bar{E}]/n$ where V_0 is the space-average potential in the metal, ϕ the work function, E the Fermi energy and n the valency of the metal. Changes in these quantities are seen at low temperatures and in strong magnetic fields. It is suggested that the relation may be used to determine V_0, which controls the refractive index for fast electrons, when the other quantities are known. W. M. LOMER

539.11 : 537.311.33

Forbidden and allowed bands in impurity semiconductors and disordered alloys. *See Abstr.* 7038

539.11 : 537.311.33 : 535.376

Theory of electroluminescence. *See Abstr.* 6953

539.11 : 548.7

7229. On the theory of a polar model of a metal in a magnetic field. G. E. Zil'berman. *Zh. éksper. teor. Fiz.*, **25**, *No.* 3(9) 313–21 (1953) In Russian.

The energy in a magnetic field of a crystal containing an excess electron or hole is calculated on the basis of a polar model of a metal. The expression obtained

for both these cases has the same form as the expression for a free electron in a magnetic field. The case of the exciton is examined also. J. M. RADCLIFFE

MOLECULES 539.13

539.13 : 539.132

7230. Collision excitation of molecular vibrations in halogen-substituted methanes. T. D. ROSSING AND S. LEGVOLD. *J. chem. Phys.*, **23**, *No.* 6, 1118–25 (*June*, 1955).

Departures from the equilibrium between vibrational and translational energies in gases are characterized by relaxation times which depend upon the ease with which vibrations may be excited or de-excited by collisions. The de-excitation process has been discussed by various authors on the basis of the relative velocity of approach of two colliding molecules and on the basis of the relative energy of approach. The dispersion of ultrasound has been measured in fourteen halogen-substituted methanes and compared with existing data. Binary collisions were found to be responsible for the excitation of vibrations, and all the gases were found to have a single relaxation time indicating a strong intermodal coupling. The probability, in a collision, of exciting or de-exciting molecular vibrations was found to depend upon the relative energy of approach of the molecules. Molecules with the same number of halogen substitutions resemble each other in this respect. The data suggest that the colliding molecules might form a complex molecule with a short lifetime during which energy exchange takes place readily. A.

539.132 : 539.133

7231. General relation between potential energy and internuclear distance for diatomic and polyatomic molecules. I. E. R. LIPPINCOTT AND R. SCHROEDER. *J. chem. Phys.*, **23**, *No.* 6, 1131–41 (*June*, 1955).

A general relation is proposed which has the form $V = D_e[1 - \exp(-n\Delta r^2/2r)] \times [1 + af(r)]$, where the parameter n is defined by the equation $n = k_e r_e/D_e$. For large values of r, the $f(r)$ term assumes the form of a Lennard-Jones (6–12) repulsive potential. With $a = 0$ the function assumes a simple form which is numerically easier to use and much more accurate than the Morse function. By using the simple function dissociation energies are readily calculated with greater accuracy than hitherto possible through the use of bond lengths, force constants and anharmonicity constants. Independent empirical methods are given for evaluating the parameter n and with its use anharmonicity constants as well as dissociation energies may be calculated more accurately than was possible previously. The use of the general relation gives improved correlations and predictions of the five spectroscopic constants r_e, k_e, D_e, $\omega_e x_e$ and α_e. The wide application of these potential functions to a large number of molecules indicates that the potential energy curves for most molecules have a general form to which the proposed relation is a reasonable approximation. The application of the proposed functions to strongly ionic or charged molecules has not been fully investigated. A.

539.132 : 539.153.4

7232. A new approach to atomic functions for quantum chemical calculations. H. PREUSS. *Z. Naturforsch.*, **10a**, *No.* 4, 267–9 (1955) In German.

A set of approximate L shell atomic functions is suggested, the radial parts of which contain nodes. These functions can be applied to polycentre problems with moderate ease, as the exchange integrals can be evaluated without difficulty and can also be adapted to the application to orbitals of higher shells. The variation method can be applied, as they contain a number of parameters. The application of the method to the L state of the H atom gave practically zero error. A. J. TAYLOR

539.132

7233. The force field, vibration frequencies, normal co-ordinates, infra-red and Raman intensities for benzene. D. H. WHIFFEN. *Phil. Trans A*, **248**, *No.* 942, 131–54 (1955).

A quadratic force field with twenty-six non-zero constants is chosen for benzene and reasons are given for preferring the constants chosen when alternative values are possible. Using this field all the vibration frequencies of C_6H_6, C_6H_5D, *ortho*-, *meta*- and *para*-$C_6H_4D_2$, *sym.* and *vic.* $C_6H_3D_3$, *para*-$C_6H_2D_4$ and C_6D_6 are calculated and found to agree with the experimental values of Ingold and co-workers to better than 2%. Four dipole moment derivative parameters are introduced to give satisfactory indications of the infrared absorption intensities and ten polarizability parameters are used to give satisfactory indications of Raman shift intensities and degrees of polarization. The alternative B_{2u} class assignment of Mair and Hornig is also discussed. A.

539.132

7234. The force constants of the molecular vibration of $SiO_4(CH_3)_4$. K. IGUCHI. *J. Phys. Radium*, **16**, *No.* 5, 401–4 (*May*, 1955) In French.

A theoretical equation is derived for the fundamental vibration frequencies of $SiO_4(CH_3)_4$. The vibrational force constants of silicates, derived using this equation, are compared with those obtained by other authors. G. I. W. LLEWELYN

539.132

7235. Molecular constants and nuclear-molecular interactions of Li^7F^{19} by the molecular beam electric resonance method. R. BRAUNSTEIN AND J. W. TRISCHKA. *Phys. Rev.*, **98**, *No.* 4, 1092–8 (*May* 15, 1955).

The electric resonance method of molecular beam spectroscopy was used to observe the Li^7F^{19} spectra arising from transitions of the type $(J, m_J) \rightarrow (J, m_J')$. Data were taken for the $(1, 0) \rightarrow (1, \pm 1)$ and $(2, 0)$ $(2, \rightarrow \pm 2)$ transitions for the $v = 0$ and $v = 1$ vibrational states. The latter transitions were observed by a double-quantum process which occurs by the absorption or stimulated emission of two quanta. From the analysis of the hyperfine structure, the signs and magnitudes of the Li^7 electric quadrupole constant (eqQ) the F^{19} and Li^7 spin-rotation constant $c_{F^{19}}$ and c_{Li^7} respectively, and the nuclear dipole-dipole interaction, $g_1 g_2(\mu_N)^2/r^3 h$, were determined. The internuclear distance was determined from the latter constant. $(\mu^2 A)$ was determined from the strong-field data, where μ is the permanent electric dipole moment

and A is the moment of inertia. The dipole moment was then calculated from $(\mu^2 A)$ and the internuclear distance. The nuclear-molecular constants are:

	$v = 0$	$v = 1$
$(eqQ/h)_{Li^7}$ (kc/s)	$+412{\cdot}0 \pm 7{\cdot}0$	$+412{\cdot}0 \pm 7{\cdot}0$
$(c/h)_F$ (kc/s)	$+32{\cdot}9 \pm 1{\cdot}0$	$+32{\cdot}4 \pm 1{\cdot}0$
$(c/h)_{Li^7}$ (kc/s)	$+2{\cdot}2 \pm 0{\cdot}6$	$+1{\cdot}8 \pm 0{\cdot}6$
$g_1 g_2 (\mu_N)^2/r^3 h$(kc/s)	$+12{\cdot}8 \pm 2{\cdot}0$	$+11{\cdot}3 \pm 2{\cdot}0$

The molecular constants determined for Li^7F^{19} are:

$(\mu^2 A)$, 10^{-76} c.g.s. units	$837{\cdot}1 \pm 0{\cdot}9$	$872{\cdot}3 \pm 1{\cdot}0$
r, A	$1{\cdot}51 \pm 0{\cdot}08$	$1{\cdot}57 \pm 0{\cdot}08$
μ, Debye units	$6{\cdot}6 \pm 0{\cdot}3$	$6{\cdot}4 \pm 0{\cdot}3$
ω_e, cm^{-1}	646 ± 32	

The $(2, 0) \rightarrow (2, \pm 2)$ double-quantum transitions of Li^6F^{19} were also observed, from which the following constants were determined: $Li^6F\omega_e = 756 \pm 38\,cm^{-1}$; $(\mu^2 A)_0(Li^7F)/(\mu^2 A)_0(Li^6F) = 1{\cdot}120 \pm 0{\cdot}001$; $(\omega_e)_{Li^6F}/(\omega_e)_{Li^7F} = 1{\cdot}17 \pm 0{\cdot}02$. A.

539.132

7236. Molecules with tetrahedral and octahedral symmetry. II. Energy calculations and molecular constants for methane, silane and germane. R. A. BALLINGER AND N. H. MARCH. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 504–16 (*July*, 1955).

For previous part, see Abstr. 1803 (1953). Detailed energy calculations for CH_4, SiH_4 and GeH_4 have been carried out using the Thomas–Fermi approximation together with a nuclear field which is averaged over all orientations about the central nucleus. The energy, including exchange, has been calculated using the unmodified Thomas–Fermi electron densities as variation functions, and in this way bond lengths and force constants for the three molecules have been obtained. The effect of exchange is very marked, agreement with experiment being quite reasonable when it is included in this way. In order to test the accuracy of this procedure, a scale factor has been introduced and used as a variational parameter. In this refined approximation, calculations have been made for SiH_4, thus enabling improved charge distributions to be obtained. Energy curves are also presented for this molecule, showing separately the variations of kinetic, potential and exchange energies with internuclear distance. It is shown that whilst the scale factor has an appreciable effect on the separate energy curves, the total energy is virtually unchanged. Finally, the reason why the exchange energy is of considerable importance in the theory is briefly discussed, and some observations are made concerning the rather abnormal bonding in GeH_4. A.

539.132

7237. Molecules with tetrahedral and octahedral symmetry. III. Theoretical basis of the "smoothing approximation." R. A. BALLINGER AND N. H. MARCH. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 517–18 (*July*, 1955).

Clarifies the basic theoretical status of the "smoothing approximation" used in previous parts (see preceding abstract).

539.132

7238. On the determination of normal vibration frequencies of polyatomic molecules. F. MATHIS. *Ann. Fac. Sci. Univ. Toulouse*, **18**, 193–208 (1954) In French.

Review of formulation for co-ordinate systems and secular equations. J. HAWGOOD

539.132

7239. Structure of deformation bands of dichlorodifluoromethane near 447 cm^{-1}. A. HADNI. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1702–4 (*April* 25, 1955) In French.

Reports experiments on these absorption bands, in the gas, at a resolution of $0{\cdot}7\,cm^{-1}$. Three fundamental deformation frequencies are assigned (in cm^{-1}) as: ν_7, 436·9; ν_9, 447·4; ν_4, 454·2 (doublet at 452·6, and 455·9). The band at 472 is interpreted as $\nu_6 - \nu_4$, and an isotopic fine structure is found in ν_7. J. HAWGOOD

539.132

7240. Effect of Fermi resonance on the centrifugal stretching constants in CO_2. C. P. COURTOY AND G. HERZBERG. Letter in *J. chem. Phys.*, **23**, *No.* 5, 975–6 (*May*, 1955).

Reports large differences in the values of this constant (D) between individual levels in Fermi polyads in the vibrational spectrum of CO_2. The average D-values for a polyad are the same as that for the lowest vibrational level and the monads, $\sim 13{\cdot}8\ 10^{-8}\,cm^{-1}$ for Σ states, but vary for the bands of the tetrad $(3\nu_1 + \nu_3)$ from 7·6 to 21·4 $10^{-8}\,cm^{-1}$, and in proportion to the order for other polyads. J. HAWGOOD

539.132

7241. Relation of the vibrational constant ω_e of molecule XY with those of XX and YY. Y. P. VARSHNI. *Z. phys. Chem.* [*Leipzig*] **204**, *No.* 3–4, 188–93 (*May*, 1955).

The proposed relation between a, b and c, the ω_e values for XY, XX and YY, when X and Y are in the same sub-group, is $a = 0{\cdot}3(bc)^{1/2} + 0{\cdot}35(b + c)$. Agreement with experiment is good, except for PN, AsN and SbN. J. HAWGOOD

539.132

7242. The C=O valence vibration of ketones in the liquid state. M.-L. JOSIEN, J. LASCOMBE, J. LECOMTE AND J.-P. MATHIEU. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1982–3 (*May* 16, 1955) In French.

Measurement of the spectra of eight aliphatic monoketones shows that the C=O frequency is generally about $3\,cm^{-1}$ higher in the infrared than the Raman spectrum. G. I. W. LLEWELYN

539.132 : 532.73

7243. Influence of solvents on the C=O valence vibration of acetone, acetophenone and cyclohexanone. M.-L. JOSIEN AND J. LASCOMBE. *J. Chim. phys.*, **52**, *No.* 2, 162–8 (*Feb.*, 1955) In French.

Reports and discusses results of experiments on the infrared absorption spectra of these ketones, as liquids and in dilute solution in various polar and non-polar solvents. As for NH vibrations [Abstr. 9457–8 (1954)], the Kirkwood–Bauer relation holds for shifts induced by non-polar solvents, and, using the high-frequency dielectric constant, the shifts for polar solvents are greater than this relation predicts, an effect attributable to association. Comparison of

infrared and Raman spectra suggests a coupling of acetone molecules, via the C=O in the liquid state, but not of molecules of acetophenone or cyclohexanone. No fine structure in the C=O band has been found. J. HAWGOOD

539.132 : 535.343

7244. The spectrophotometric determination of steric hindrance in stilbene derivatives. R. N. BEALE AND E. M. F. ROE. *Photoelect. Spectrom. Group Bull.* [*Cambridge*] *No.* 7, 155–9 (*Sept.*, 1954).

Some derivatives of basic stilbene carrying the basic group at position 4 have growth-inhibitory and carcinogenic properties; others which contain substituents which disturb the planarity of the molecule do not have these properties. The ultraviolet absorption spectra of stilbene, 4-dimethylaminostilbene and of derivatives of these compounds were observed. When the substituent caused a sufficient disturbance of the planarity a hidden transition on both slopes of the long-wavelength band was observed. The effects of methyl substitution in stilbene on the oscillator strength (f) were calculated for various positions, and it was found that, if f changes are independent and additive, the groups perturb the molecule but little; a hindering substituent, however, shows a decrement in f value. A similar effect was found for the $N(CH_3)_2$ group, which at position 4 causes a large increment in f value. The difference in the band between compounds substituted at position 4 and positions 2 or 3 is due to the fact that the latter substituents disturb the entire symmetry of the molecule. A. J. TAYLOR

539.132

7245. On the $^4\Pi$ state of the O_2^+ molecule. Á. BUDÓ AND I. KOVÁCS. *Acta phys. Hungar.*, **4**, *No.* 3, 273–90 (1955) In German.

The multiplet splitting deviates from the formulae derived with van Vleck's theory. However, agreement with experiment is reached if it is treated as a perturbation of the $^4\Pi$-state by two $^2\Pi$-states. The approximate position of the $^2\Pi$-state can be derived although it has not yet been observed. J. JACOBS

539.132

7246. Theory of perturbations in the metallic model approximation. Application to changes in absorption spectra due to substitution. S. NIKITINE AND S. G. EL KOMOSS. *J. Chim. phys.*, **52**, *No.* 2, 108–13 (*Feb.*, 1955) In French.

The substitution of a central N in a symmetrical polymethine is represented by the introduction of a square potential well, width a, into the constant potential box, length L, of the usual model. The effect on the first absorption band is found to be very sensitive to the value of a/L. It is suggested that a should be 2·5 bond lengths; this gives reasonable agreement with experiment, using the well depth as a parameter, ~3 eV. J. HAWGOOD

539.132

7247. Incomplete electronic configurations. II. Study of certain organic radicals and biradicals by the self-consistent molecular field method. G. BERTHIER. *J. Chim. phys.*, **52**, *No.* 2, 141–9 (*Feb.*, 1955) In French.

Calculations by the method of Pt I [Abstr. 2956 (1955)] have been made on the allyl radical, CH_2–CH–CH_2, and on the hypothetical diallylene biradical, $(CH_2)_2$–C–C–$(CH_2)_2$. Comparisons with calculations by the ordinary MO method show that the main differences consist of the removal of degeneracies predicted by the cruder method. For the allyl radical, a careful discussion is given of the experimental data which are properly to be compared with the theoretical resonance energy. J. HAWGOOD

539.132

7248. Note on the branching condition in the one-dimensional free electron gas model. A. A. FROST. Letter in *J. chem. Phys.*, **23**, *No.* 5, 985 (*May*, 1955).

Argues that the new Kuhn condition [Abstr. 2947 (1955)] with $K \neq 0$ applies only if the potential energy involves δ-functions. F. LACHMAN

539.132 : 537.561

7249. The ionization potentials of some conjugated molecules. I. OMURA, H. BABA AND K. HIGASI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 4, 317 (*April*, 1955).

Reports results of appearance potential measurements in a mass-spectrometer for benzene, toluene, pyridine, pyrrole, furan and thiophene, results for all of which agree with previous work, and for cyclo-octatetraene, for which the first ionization potential is 8·63 ± 0·15 eV. J. HAWGOOD

539.132

7250. Nuclear magnetic resonance in solid hydrogen with various ortho concentrations. T. SUGAWARA, Y. MASUDA, T. KANDA AND E. KANDA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **7**, *No.* 1, 67–83 (*Feb.*, 1955).

This was studied at temperatures down to 1·17°K. The results on normal hydrogen were in agreement with those of Reif and Purcell. The width of the centre peak at 4·2°K was 5·4 gauss in normal hydrogen and decreased with falling ortho concentration. In crystals with the concentration higher than 63%, two side peaks with the separation of 39·5 gauss appeared at temperatures characteristic of the concentration. The centre peak in low concentration hydrogen showed a fine structure at low temperatures. The theoretical considerations of Reif and Purcell concerning the state of solid hydrogen were examined and extended to interpret the results. The assumption of asymmetric crystalline potential which lifts the rotational degeneracy of the ortho molecule was capable of explaining most of the experimental results in ortho-para mixtures. The appearance of side peaks was attributed to the onset of co-operative ordering of the axes of rotation of the ortho molecules. The fine structure in low concentration hydrogen was considered to be due to the different local surroundings of the ortho molecules. The well-known specific heat anomally and the ortho-para conversion in the solid were discussed on the same basis. The magnetic resonance absorption in solid deuterium is also studied. A.

539.132

7251. Concentration dependence of chemical exchange and NMR multiplet structure in water-ethanol mixtures. I. WEINBERG AND J. R. ZIMMERMAN. Letter in *J. chem. Phys.*, **23**, *No.* 4, 748–9 (*April*, 1955).

With up to 20% H_2O in C_2H_5OH the nuclear magnetic resonance frequencies of the OH groups in each

species are separate on account of the differing chemical shifts. Above this H_2O concentration the lines coalesce, indicating the proton lifetime in any one OH state to be less than 0·05 sec. The splitting of the CH_2 group resonance due to the OH spin is also affected. D. H. WHIFFEN

539.132

7252. Electron exchange coupling of nuclei in aromatic systems. H. S. GUTOWSKY, L. H. MEYER AND D. W. MCCALL. Letter in *J. chem. Phys.*, **23**, *No.* 5, 982 (*May*, 1955).

539.132

7253. Nuclear spin-spin coupling in substituted benzenes. E. B. BAKER. Letter in *J. chem. Phys.*, **23**, *No.* 5, 984–5 (*May*, 1955).

539.132

7254. Nuclear quadrupole resonances of Sb^{121} and Sb^{123}. R. G. BARNES AND P. J. BRAY. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1177–8 (*June*, 1955).

Resonance frequencies are reported for Sb_2O_3, $Sb(C_6H_5)_3$, $Sb(C_3H_7O)_3$, $SbCl_3$ for Sb^{121} and Sb^{123} and for I^{127} in SbI_3 and BiI_3. D. H. WHIFFEN

539.132

7255. Overhauser effect in nonmetals. A. ABRAGAM. *Phys. Rev.*, **98**, *No.* 6, 1729–35 (*June* 15, 1955).

A survey is made of different ways in which nuclear spins can relax through their interaction with electronic spins. It is shown that the maximum amount of nuclear polarization which can be obtained by saturating the electronic resonance depends: (*a*) on the type of interaction between electronic and nuclear spins, namely dipole-dipole type, scalar product type or any combination of the two; (*b*) on the mechanism whereby the "lattice" provides the energy for the relaxation. The case of a nucleus belonging to a paramagnetic ion is examined in some detail with reference to the recent experiment of Honig on arsenic-doped silicon. It is shown that while an Overhauser effect may be expected, this offers no support for an interpretation of Honig's results as a hundred per cent nuclear polarization. A.

539.132

7256. Overhauser nuclear polarization effect and minimum entropy production. M. J. KLEIN. *Phys. Rev.*, **98**, *No.* 6, 1736–9 (*June* 15, 1955).

Gives a simple set of kinetic equations which describe the Overhauser method of producing nuclear polarization by saturating the electronic spin resonance. It is shown that thermodynamically the process consists of absorption of microwave energy and its conversion into heat. In the steady state this process satisfies the principle of minimum entropy production. A.

539.132

7257. Nuclear magnetic resonance saturation and rotary saturation in solids. A. G. REDFIELD. *Phys. Rev.*, **98**, *No.* 6, 1787–809 (*June* 15, 1955).

Nuclear spin-lattice relaxation times of Al^{27} in pure Al and Cu^{63} in annealed pure Cu have been measured with a nuclear induction spectrometer, by the method of saturation. The experimental values of T_1 are $4·1 \pm 0·8$ milliseconds for Al^{27} and $3·0 \pm 0·6$ milliseconds for Cu^{63}, in reasonable agreement with theory. The dispersion mode of the nuclear resonance was also observed, and it was found that χ' (the real part of the r.f. susceptibility) does not saturate at the same level as the absorption, χ'', but remains roughly constant out to a radio-frequency field intensity of about 2 gauss. Both χ' and χ'' become narrower and nearly Lorentzian in shape above saturation. When the d.c. magnetic field modulation is increased from 14 to 41 c/s the phase of the dispersion signal lags behind the modulation, presumably because the modulation period is then comparable to T_1. Large dispersion signals above saturation have also been observed for the Na^{23} resonance in NaCl. This behaviour of the dispersion mode is in conflict with the predictions of Bloembergen, Purcell and Pound and of the Bloch equations. The validity of these theories is re-examined, and it is concluded that although they are applicable to nuclear resonance in liquids and gases, and to solids at small r.f. intensities, they contain incorrect assumptions as applied to solids at high r.f. power levels. The theory of Bloembergen, Purcell and Pound is based on an assumption equivalent to that of a spin temperature. It is shown that the spin state cannot be strictly described by a spin temperature because the phases of the spin quantum states are not incoherent, as required by the temperature concept. The transverse decay of the nuclear magnetization predicted by the Bloch equations is shown to be partially forbidden by energy and entropy considerations if a large r.f. field at the resonance frequency is continuously applied to the solid. A theory is developed which is applicable only to solids at r.f. magnetic field intensities well above the saturation level and which is in reasonable agreement with the experimental observations. The Hamiltonian is transformed to a co-ordinate system rotating at the frequency of the r.f. field. The resulting time-dependent parts of the spin-spin interaction are non-secular perturbations on the time-independent part, and can therefore be ignored. Statistical mechanics is applied to the remaining stationary spin Hamiltonian; specifically it is assumed that the spin system is in its most probable macrostate (a canonical distribution of quantum states) with respect to the transformed spin Hamiltonian. This assumption is justified because the transformed spin Hamiltonian is effectively time independent and the spin-lattice interaction is small, and it is analogous to assumptions basic to classical acoustics and fluid mechanics. The spin-lattice interaction merely determines the expectation value of the transformed spin Hamiltonian, which can be readily calculated under the assumption that the expectation value of the spin angular momentum of each spin is relaxed independently to its thermal equilibrium value by the lattice in time T_1. Both fast and slow modulation of the d.c. magnetic field can be treated. "Rotary saturation" is observed by applying an audio-frequency magnetic field to the sample in the d.c. field direction while observing the dispersion derivative at resonance with a large r.f. field H_1. When the audio-frequency approaches γH_1 the dispersion signal decreases and goes through a minimum. The effect is easily treated theoretically in solids, liquids and gases by using a rotating co-ordinate system, and is a rotary analogue of ordinary saturation. It is a convenient method for calibrating r.f. magnetic fields and appears potentially capable of

providing useful information on the solid state. Experimental data on rotary saturation are presented and discussed. A.

539.132 : 548.736.6

7258. An investigation of the nuclear resonance absorption spectrum of Al^{27} in a single crystal of euclase. R. G. EADES. *Canad. J. Phys.*, **33**, *No.* 6, 286–97 (*June*, 1955).

The nuclear magnetic resonance spectrum of Al^{27} in a single crystal of $HBeAlSiO_5$ (euclase) in an external magnetic field of 7000 gauss is described. The Al^{27} nuclei are found to occupy two kinds of lattice sites which differ from each other only in the orientation of the principal axes of the electric field gradient tensors whose eigenvalues are all distinct, but identical at both sites. The absolute value of the quadrupole coupling constant for both groups of Al^{27} nuclei is found to be 5173 ± 10 kc/s and the axial asymmetry parameter of the field gradient tensors at both the lattice positions is $0{\cdot}698 \pm 0{\cdot}009$. The two sets of principal axes are reflections of each other in the (010) plane which is consistent with the symmetry of the proposed crystal structure. The theoretical dependence of the spectrum line frequencies on the applied magnetic field is given for one group of Al^{27} nuclei and for one orientation of the crystal in fields up to 2000 gauss; the feasibility of checking this experimentally is discussed. A.

539.132

7259. Extension of Hund's rule. G. F. KOSTER. *Phys. Rev.*, **98**, *No.* 2, 514–15 (*April* 15, 1955).

It is shown that in an n-electron system, if these n electrons are assumed to occupy n orthogonal one-electron orbitals, the state of highest multiplicity has the lowest energy. A.

539.132

7260. Bond energies in organic fluorine compounds. N. W. LUFT. Letter in *J. chem. Phys.*, **23**, *No.* 5, 973–4 (*May*, 1955).

With the use of recently published values for enthalpies of formation, the C–F bond dissociation energies of alphatic fluorine compounds could be calculated in various cases. The results are tabulated: they vary from 100 ± 5 kcal/mole for CCl_3F to 138 ± 4 kcal/mole for CF_4. A. J. TAYLOR

539.132

7261. Ionization potential of benzyl radical. I. TANAKA AND C. KOMATSU. Letter in *J. chem. Phys.*, **23**, *No.* 5, 976–7 (*May*, 1955).

Theoretical. SCF MO orbitals are calculated for the benzyl cation (6 electrons) and used to discuss the ionization potential I_p of the benzyl radical (7 electrons). From the energy and coefficients of the fourth orbital, $I_p(C_6H_5CH_2) = 7{\cdot}98$ eV (experiment $7{\cdot}73$ eV), and for the methyl benzyl radicals, $I_p(para\text{-}) < I_p(ortho\text{-}) < I_p(meta\text{-})$, also agreeing with experiment. J. HAWGOOD

539.132

7262. The interaction of two excited hydrogen atoms. M. A. JASWON AND H. AGHAJANIAN. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 5, 444–7 (*May*, 1955).

Theoretical examination of the concept of perfect pairing of directed orbitals in molecules, by a molecular orbital treatment of σ-bond formation by $2s$–$2p$ hybrids on two H atoms. MO's for H_2^+ are formed from Slater AO's, and used for the excited H_2 molecule; a binding energy of $4{\cdot}4$ eV at equilibrium distance $1{\cdot}6$ Å is predicted, supporting the concept of strong σ-bonds between hybrid orbitals. J. HAWGOOD

539.132

7263. Excited electronic states of 1, 3-butadiene. R. K. NESBET. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 322–30 (*June* 21, 1955).

Approximate self-consistent orbitals for excited electronic states of *cis*- and *trans*-1, 3-butadiene are obtained by a modification of Roothaan's procedure, in the non-emprical π-electron approximation. The integrals used were evaluated by Parr and Mulliken for calculation of the ground-state electronic wave-function. The effects of configuration interaction are calculated by an approximate method and compared with an exact calculation. Molecular orbitals have been obtained both with and without the auxiliary condition that spatial factors of both α and β spin-orbitals should be members of a single orthogonal set. Semi-empirical values for the basic integrals, due to Pariser and Parr, have also been used to calculate the energies of excited states by the approximate configuration interaction method. Energy levels derived from the Pariser–Parr integrals are in close agreement with observed levels, which differ considerably from those calculated from the Parr–Mulliken non-empirical integrals. A.

539.132

7264. The molecular orbital theory of chemical valency. XIX. The charge density function. P. P. MANNING. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 415–23 (*June* 21, 1955).

For Pt XVIII, see Abstr. 10380 (1954). An account of the properties of the electronic charge density function in the first and higher approximations in molecular orbital theory is given. Application to conjugated molecules allows a simple understanding of the relation between bond order and bond length in both symmetrical and unsymmetrical bonds. The final section shows how any diagonal element of the charge-density matrix may be expressed as a basic constant modified by a term taking account of any difference in the number of electrons with each spin and by further terms which may be regarded as charge drifts from one orbital to another. A.

539.132

7265. The molecular orbital theory of chemical valency. XX. The energy in higher approximations. P. P. MANNING. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 424–8 (*June* 21, 1955).

The equations determining the optimum orbitals in a many-determinant approximate wave-function are given and their relation to the total energy considered. As expected, the form of the energy shows that bond energies will be nearly additive in non-conjugated molecules as long as they are not strongly polar, but that this will not be so for conjugated molecules. A.

539.133

7266. Calculation of the magnetic susceptibility of the molecule of hydrogen. J. TILLIEU AND J. GUY. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 13, 1402–4 (*March* 28, 1955) In French.

The two principal magnetic susceptibilities and the magnetic anisotropy of hydrogen have been calculated using a relationship previously established [Abstr. 1104 (1955)]. The susceptibility values deduced are in good agreement with experimental observation.

G. I. W. LLEWELYN

539.133

7267. Paramagnetic investigation of binary compounds. R. BENOIT. *J. Chim. phys.*, **52,** *No.* 2, 119–32 (*Feb.*, 1955) In French.

Reports results of measurements of the paramagnetic susceptibility and also, in some cases, of the saturation magnetization, electrical conductivity and lattice spacing of the following compounds: $FeS_n(n = 1{\cdot}0, 1{\cdot}094, 1{\cdot}125, 1{\cdot}150, 1{\cdot}165, 1{\cdot}175)$, CoS, NiS, CoS_2, NiS_2, MnS_2, CrSi, FeSi, CoSi, CeB_6, NdB_6, GdB_6, YbB_6. The results are interpreted.

E. P. WOHLFARTH

539.133

7268. Valence binding in some binary compounds. R. BENOIT. *J. Chim. phys.*, **52,** *No.* 3, 201–12 (*March*, 1955) In French.

By applying semi-empirical ideas due to Pauling and making use of results of magnetic and X-ray investigations, conclusions are drawn about the chemical structure of the compounds discussed in the preceding abstract. E. P. WOHLFARHT

ATOMS . NUCLEUS . ISOTOPES 539.15

539.152.1

7269. Remarks on a nuclear model. D. IVANENKO, N. KOLESNIKOV AND S. LARIN. *Dokl. Akad. Nauk SSSR*, **100,** *No.* 1, 37–40 (1955) In Russian.

Series of nuclear properties are quoted that are unexplained by the independent particle and collective models. It is suggested from this that at least some of the nucleons in each shell participate both in motion along quasiatomic orbits and associated in groups of two or four nucleons, with strongly correlated wavefunctions. Competition between pure shell structure and group structure will occur especially in light nuclei, where the latter should be more probable. A modification of the semi-empirical binding energies formula is suggested. S. DEDIJER

539.152.1

7270. Calculation of pairing energy by means of the eigenfunctions of the Yukawa potential. M. A. ZIEGLER. Note in *Acta phys. Hungar.* **4,** *No.* 3, 293–6 (1955).

If a strong spin-orbit force is used in the radial equation, pairing energies (which depend on the radial eigenfunctions) are obtained such that in orbits of the same azimuthal quantum number, that of higher angular momentum has the higher pairing energy.

G. E. BROWN

539.152.1

7271. On the distribution of the electric charge of the nucleus. J. REIGNIER. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41,** *No.* 2, 151–64 (1955) In French.

Experiments designed to give information on the distribution of charge inside the nucleus are discussed. A method of successive approximation is presented for calculating the distribution of charge in the nucleus from the distribution on the surface. In nearly all cases when the series converges the first approximation gives almost exact agreement with experiment. Two distributions are found to be equivalent for all the experiments discussed, provided they give the same value of a certain function of potential. D. J. PROWSE

539.152.1

7272. Neutron subshell in the region of transuranic elements. S. I. LARIN AND N. N. KOLESNIKOV. Letter in *Zh. éksper. teor. Fiz.*, **28,** *No.* 2, 243 (1955) In Russian.

A plot of α-decay energies *v. A* for elements $Z = 92$ to 100 indicates minima at 150 or 152 neutrons. A footnote added in proof suggests 152 as subshell on evidence given in Abstr. 9503 (1954). S. DEDIJER

539.152.1

7273. Energy levels of light nuclei. V. F. AJZENBERG AND T. LAURITSEN. *Rev. mod. Phys.*, **27,** *No.* 1, 77–166 (*Jan.*, 1955).

A review of work published up to November, 1954, revising but not replacing the previous compilation in Pt IV [Abstr. 2604 (1953)]. Energy-level diagrams are discussed for nuclides from He^5 to the isotopes of neon. A. O. STANESBY

539.152.1

7274. Angular correlation parameters for oriented nuclei. T. P. GRAY AND G. R. SATCHLER. Letter in *Proc. Phys. Soc. A*, **68,** *Pt* 4, 349–50 (*April*, 1955).

When the formula for the angular distribution of the radiation from oriented nuclei (Steenberg, 1953, 1954) is rewritten as a sum of Legendre polynomials, the coefficients can be expressed in terms of quantities tabulated in connection with angular correlation studies. The necessary transformations are discussed and some relevant formulae and curves are given explicitly. W. J. SWIATECKI

539.152.1

7275. On the calculation of the electrostatic energy of light nuclei. B. JANCOVICI. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 16, 1632–4 (*April* 18, 1955) In French.

If the radius of the *s* shell is reduced, as suggested previously [Abstr. 6391 (1955)], the mean square radius of the charge distribution, calculated from mirror nuclei, must be diminished. P. T. MATTHEWS

539.152.1

7276. Masses of nuclei in isobaric sequences. K. KUMAR AND M. A. PRESTON. *Canad. J. Phys.*, **33,** *No.* 6, 298–315 (*June*, 1955).

The semiempirical mass formula is known to give a rough fit to the general trend of atomic masses. A detailed correlation to within 0·5 MeV or less is attempted between observed atomic mass-differences and the predictions of a semiempirical liquid drop

formula generalized to include terms which depend on angular momentum in the way suggested by the nuclear shell model. For fixed A, it is found that, allowing for these "spin terms," the Z-dependence is parabolic. The variations of the different parameters with A and with shell changes are studied. It is found that, when close agreement with experimental values of mass is required, certain "constants" of the liquid drop formula are in fact quite dependent on A. This is interpreted to mean that the A- or Z-dependence of the formula is incomplete. Nevertheless, an empirical method of extrapolating unknown masses is suggested. A.

539.152.1

7277. Electric excitation of certain medium-weight nuclei by protons. H. MARK, C. MCCLELLAND AND C. GOODMAN. *Phys. Rev.*, **98**, *No.* 5, 1245–51 (*June* 1, 1955).

Electric excitation has been used to study energy levels in sixteen elements ranging from scandium to iodine. Seventeen γ-rays have been observed. Electric quadrupole transition probabilities for the energy levels corresponding to these γ-rays have been calculated from the measured electric-excitation cross-sections. The results are substantially larger than those expected from transitions of single particles but are significantly and uniformly lower than those calculated from the energies of the levels by using the hypothesis of rotational excitation. Similar observations have been made previously for a series of heavy nuclei. It is suggested that this effect results from either a nonuniform distribution of charge and mass in the nucleus or from a breakdown of the assumption that the collective motion can be represented as an irrotational flow. A.

539.152.1

7278. Electric monopole transitions in C^{12} and O^{16}. L. I. SCHIFF. *Phys. Rev.*, **98**, *No.* 5, 1281–5 (*June* 1, 1955).

The matrix elements for the electric monopole $(0^+ \rightarrow 0^+)$ transitions between the ground and 7·68 MeV state in C^{12} and between the ground and 6·06 MeV state in O^{16} may be estimated from inelastic electron scattering and from the pair emission lifetime, respectively. The two are equal to each other within the rather large error of the electron scattering determination, and are given by $(\Sigma_P r_P^2)_{f0} \cong 3 \cdot 8 \times 10^{-26}\,\mathrm{cm}^2$, where 0 and f represent initial and final states of the nucleus, and r_P is the radial distance of a proton from the centre of the nucleus. Calculations based on the α-particle model and on an elastic-fluid model yield three to five times this experimental value. Therefore, a calculation was made in the case of C^{12}, based on the jj-coupling independent-particle model, according to which two nucleons undergo transitions between the $p_{\frac{3}{2}}$ shell and the $p_{\frac{1}{2}}$ shell. The matrix element vanishes if there are no internucleon forces. Pair forces are included to first order, and the sum over configurations is performed exactly by means of a Green's function. For simplicity it is assumed that the independent-particle potential is an infinitely deep square well, and that the pair interaction has zero range. Even assuming that the pair interaction has its free-space triplet magnitude, the calculated matrix element is only about one-sixth the experimental value. It is concluded, therefore, that a model that is more collective than the independent-particle model with pair interactions, and less collective than the α-particle or elastic-fluid models, is required to account for the experimental results. A.

539.152.1

7279. Properties of excited states of Pd and Cd nuclei by Coulomb excitation. G. M. TEMMER AND N. P. HEYDENBURG. *Phys. Rev.*, **98**, *No.* 5, 1308–10 (*June* 1, 1955).

The first-excited (2^+) states of most even-even nuclei of Pd and Cd have been Coulomb-excited using enriched targets. Three of these states were previously unknown (Pd^{108}, Pd^{110} and Cd^{116}). Excited states were also observed in Pd^{105}, Cd^{111} and Cd^{113}, the latter yielding a new level at 290 keV. Transition probabilities (lifetimes) for these transitions have been determined and show definite systematic trends. A.

539.152.1

7280. Studies on the α-particle model of nuclei. I. A. HERZENBERG. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 986–1007 (*June*, 1955).

The kinetic energies of the $A = 4n$ nuclei (with $Z = N = 2n$) up to $A = 40$ are estimated on the basis of the α-particle model. This estimate is used, together with known regularities in the binding energies and an estimate of the Coulomb energy, to show that, on this model, there must be an additive attractive interaction between neighbouring α-particles. New physical criteria are given for the stability of the α-particles and the degree to which their motion is adiabatic; the relevant parameters are estimated by the use of quantum mechanics. A comparison is made with the analogous situation in molecules. A.

539.152.1

7281. Studies on the α-particle model of nuclei. II. A. HERZENBERG. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1008–40 (*June*, 1955).

A formalism for the interaction of α-particles in nuclei is developed in an analogous way to the treatment of the interaction of atoms. The effective forces can be separated into a direct interaction (analogous to the long-range Coulomb interaction of ions), a nucleon exchange interaction (analogous to electron exchange) and a polarization interaction (analogous to van der Waals forces). The direct interaction is additive and independent of velocity. The nucleon exchange interaction is velocity dependent and not additive. The polarization interaction is velocity dependent, and whether or not it is additive is determined by the spin and charge dependence of the nuclear potential. The transition of the formalism to the usual treatment of atomic van der Waals forces is traced. Retardation effects due to the wave nature of the nuclear force field are unlikely to be present. It is shown that the asymptotic form of the forces between two α's with a Yukawa π-meson potential contains exponential factors $\exp[-s/1 \cdot 4]$ (direct), $\exp[-s/0 \cdot 7]$ (polarization), $\exp[-s/0 \cdot 6]$ (exchange), where s is the separation of the mass centres in units of 10^{-13} cm. Arguments are given against the conclusion from earlier work that α-clusters in nuclear matter would dissolve. A.

539.152.1 : 539.172.13

7282. On the optical model for nucleon scattering by oxygen. Y. Fujimoto and A. Hossain. *Phil. Mag.*, **46**, 542–5 (*May*, 1955).

Using a complex potential of the form suggested by Feshbach *et al.* [Abstr. 524 (1955)] the nuclear radius and potential parameters were adjusted to give a best fit to the experimental angular distribution of 9·5 MeV protons elastically scattered by oxygen. The best agreement is found for a nuclear radius of $1{\cdot}45\times10^{-13}A^{\frac{1}{3}}$ cm and a well depth between 30 and 36 MeV with a suitable absorption term. The same potential depth also gives good agreement between the calculated and experimentally determined total cross-section and angular distribution for 14·1 MeV neutrons scattered by oxygen. It is suggested that the effective depth of the potential well decreases as the energy of the incident neutron increases, and that the mean free path of nucleons within a nucleus varies with energy. J. HUGHES

539.152.2

7283. On the magnetic moment and rotational spectrum of thulium^{169}. B. R. Mottelson and S. G. Nilsson. *Z. Phys.*, **141**, *No.* 1–2, 217–20 (1955) In German.

The observed magnetic moment, the "decoupling factor" deduced from the rotational spectrum and the relative intensities of associated γ-rays are accounted for quantitatively using individual particle wave-functions calculated with the axially symmetric potential of Nilsson [*K. Danske Vidensk. Selsk., mat.-fys. Medd.* (1955), in press], using a ratio of axes of 1·3, as given by the observed quadrupole moment. W. J. SWIATECKI

539.152.2

7284. Nuclear electric quadrupole moment of potassium 39. G. J. Ritter and G. W. Series. Letter in *Proc. Phys. Soc. A*, **68**, *Pt* 5, 450–2 (*May*, 1955).

Preliminary double resonance experiments in which the polarization of the resonance radiation is observed as a function of radiofrequency and of magnetic field strength gave $\Delta m_I = 0$, $\Delta(m_I + m_J) = 0$ and $F_{3\to2}$ and $F_{2\to1}$ transitions in the $5P_{3/2}$ state of K^{39} under appropriate conditions. The spin is 3/2 and the interaction constants $a = 1{\cdot}9 \pm 0{\cdot}2$ Mc/s for magnetic coupling, $b = 1{\cdot}0 \pm 0{\cdot}025\times a$ for quadrupole coupling whence $Q = +0{\cdot}14\times10^{-24}\,\mathrm{cm}^2 \pm 25\%$.

D. H. WHIFFEN

539.152.2

7285. Matrix treatment of nuclear induction. E. T. Jaynes. *Phys. Rev.*, **98**, *No.* 4, 1099–105 (*May* 15, 1955).

By use of matrix notation, solutions of the Bloch equations may be kept in simple, manageable form even in the case of applied fields that are complicated functions of time. Effects that from the usual standpoint are grossly nonlinear appear as linear relations between matrices, of the same form that one encounters in simple radioactive decay problems. A general property of transients in the case of an arbitrary repetitive applied signal is established, and a formalism is set up in terms of which a large class of special problems may be solved. A.

539.152.2

7286. Nuclear induction in inhomogeneous fields. A. L. Bloom. *Phys. Rev.*, **98**, *No.* 4, 1105–11 (*May* 15, 1955).

The mathematical methods developed by Jaynes (preceding abstract) are applied to the study of nuclear resonance in inhomogeneous magnetic fields. It is shown that a description of delayed-signal phenomena such as spin echoes is greatly simplified by the use of the spinor representation involving 2×2 transformation matrices. The original results of Hahn on spin echoes are rederived in simplified fashion and more complicated situations are discussed, including large numbers of pulses, exact time dependence in extremely inhomogeneous fields and continuous pulse trains. Several previously unreported types of delayed-signal phenomena are discussed and illustrated experimentally by oscilloscope traces. The apparatus used to study nuclear induction in very inhomogeneous fields is briefly discussed. A.

539.152.2

7287. Nuclear moments of Ac^{227}. M. Fred, F. S. Tomkins and W. F. Meggers. Letter in *Phys. Rev.*, **98**, *No.* 5, 1514 (*June* 1, 1955).

Preliminary values for the nuclear magnetic dipole ($+1{\cdot}1$ nuclear magnetons) and electric quadrupole ($-1{\cdot}7\times10^{-24}\,\mathrm{cm}^2$) moments of Ac^{227} have been derived from the hyperfine structure patterns of 9 lines of Ac II. A. O. STANESBY

539.152.2

7288. Spin, quadrupole moment, and mass of selenium-75. L. C. Aamodt and P. C. Fletcher. *Phys. Rev.*, **98**, *No.* 5, 1224–9 (*June* 1, 1955).

The microwave spectrum of $OCSe^{75}$ has been observed and from it the spin, quadrupole moment and mass of Se^{75} were measured. Frequencies of the six observed lines of the $J = 2 \to 3$ rotational transition give a nuclear spin of 5/2, a quadrupole coupling constant $eqQ = 946{\cdot}0$ Mc/s, and a rotational constant $B_0 = 4\,081{\cdot}926$ Mc/s. From these and other known properties of the OCSe molecule, one obtains the quadrupole moment of Se^{75} as $Q = 1{\cdot}1\times10^{-24}\,\mathrm{cm}^2 \pm 20\%$, and the mass ratio $(M_{Se^{75}} - M_{Se^{76}})/(M_{Se^{75}} - M_{Se^{80}}) = 0{\cdot}199\,566 \pm 0{\cdot}000\,030$. The odd-even mass difference for Se^{75} is $1{\cdot}5 \pm 0{\cdot}2$ mMU. The observed spin disagrees with that expected from the shell model which predicts a spin of 1/2 or 9/2. Three possible nuclear configurations which agree with the observed spin and also indicate a positive quadrupole moment are $[p_{1/2}(g_{9/2})^2]_{5/2}$, $(g_{9/2})^3_{5/2}$ and $(f_{5/2})^5_{5/2}$. Magnetic moment measurements are needed to clearly distinguish between configurations. The sample material was obtained by bombarding arsenic with deuterons. Approximately $1\frac{1}{2}$ micrograms of sample material were produced but only 0·07 microgram could be used in each spectroscopic run because of difficulties in synthesizing OCSe. A.

539.152.2

7289. Nuclear moments of Nb^{93}, La^{139}, Os^{187}, and Hg^{201}. K. Murakawa. *Phys. Rev.*, **98**, *No.* 5, 1285–8 (*June* 1, 1955).

The effective charge Z^* for a d-electron was studied by means of a hyperfine structure (h.f.s.) investigation;

the screening correction ($Z - Z^*$) was found to range from 15 to about 19 for the charge number Z ranging from 27 to 78. Investigation of the h.f.s. of the spectra of Nb I and La I yielded the result that $Q(Nb^{93}) = (-0{\cdot}2 \pm 0{\cdot}1) \times 10^{-24}\,cm^2$ and $Q(La^{139}) = (+0{\cdot}6 \pm 0{\cdot}2) \times 10^{-24}\,cm^2$ respectively, in which the polarization correction (due to Sternheimer) is taken into account. In the h.f.s. of the spectrum of Os I the components due to the rarer odd isotope Os^{187} were detected and it was found that Os^{187} has a spin 1/2 and a magnetic moment most probably equal to +0·12 nm (possible range being from +0·16 nm to +0·09 nm). The quadrupole moment of Hg^{201} was calculated from the h.f.s. of $6s6p\,^1P_1$ and $6s6p\,^3P_2$ of the spectrum of Hg I, taking the configuration interaction into account, and $Q(Hg^{201}) = (+0{\cdot}45 \pm 0{\cdot}04) \times 10^{-24}\,cm^2$ was obtained. A.

539.152.2

7290. Nuclear magnetic moments of Cl^{36}, Rh^{103}, and W^{183}. P. B. Sogo and C. D. Jeffries. *Phys. Rev.*, **98**, *No.* 5, 1316–17 (*June* 1, 1955).

The nuclear magnetic resonance of Cl^{36} in HCl solution has been observed by nuclear induction, and the magnetic moment is found to be $\mu(Cl^{36}) = +1{\cdot}283\,8 \pm 0{\cdot}000\,2$ nm. Calculations on a *jj* coupling model yield $\mu(Cl^{36}) = +1{\cdot}16$ nm. The magnetic resonances of Rh^{103} and W^{183} have been observed in powdered metallic samples. The magnetic moments are found to be $\mu(Rh^{103}) = -0{\cdot}087\,90 \pm 0{\cdot}000\,07$ nm and $\mu(W^{183}) = +0{\cdot}115 \pm 0{\cdot}001$ nm, where in each case a calculated correction for the Knight shift due to the conduction electrons has been applied. A.

539.152.2

7291. Magnetic moment and mass of chlorine-36. L. C. Aamodt and P. C. Fletcher. *Phys. Rev.*, **98**, *No.* 5, 1317–23 (*June* 1, 1955).

The magnetic moment of the Cl^{36} nucleus was measured by observing the Zeeman splitting of the $F = 2 \rightarrow 2$ line in the electric quadrupole hyperfine pattern of the molecule CH_3Cl^{36} ($J = 0 \rightarrow 1$, $K = 0$ transitions). It was found to be $1{\cdot}32 \pm 0{\cdot}08$ nuclear magnetons. The magnitude of the magnetic moment was measured by using a rectangularly cross-sectioned absorption cell with plane polarized microwave radiation, and observing $\Delta M = \pm 1$ transitions. The sign of the magnetic moment was measured by using a circularly cross-sectioned absorption cell with circularly polarized microwave radiation. This allowed the $\Delta M = 1$ and the $\Delta M = -1$ transitions to be observed separately. The magnetic field was calibrated by observing the Zeeman splitting of the spectrum of CH_3Cl^{35}. This value of magnetic moment indicates a nuclear configuration $(d_{\frac{3}{2}})_N(d_{\frac{3}{2}})_P$. Measurements of the quadrupole spectrum without the Zeeman perturbation gave the following additional information: the spin of Cl^{36} was confirmed to be 2, the mass difference ratio $[m(Cl^{36}) - m(Cl^{35})]/[m(Cl^{37}) - m(Cl^{36})]$ was found to be $1{\cdot}001\,68 \pm 0{\cdot}04\%$, the molecular rotational constant of the CH_3Cl^{36} molecule was found to be $13\,187{\cdot}604 \pm 0{\cdot}015$ Mc/s, and its quadrupole coupling constant to be $-15{\cdot}83 \pm 0{\cdot}20$ Mc/s. A.

539.152.2 : 535.332

7292. Hyperfine structure and nuclear moment of Kr^{85}. E. Rasmussen and V. Middelboe. *Z. Phys.*, **141**, *No.* 1–2, 160–5 (1955) In German.

The infrared Kr I spectrum is investigated using the long-lived Kr^{85} isotope, which was selected by an electromagnetic isotope separator from Kr resulting from U^{235} fission. The nuclear spin is found to be $I = 9/2$. The ratio of magnetic moments of the odd isotopes Kr^{85} and Kr^{83} was $\mu(85)/\mu(83) = 1{\cdot}035 \pm 0{\cdot}002$ and of the quadrupole moments, $Q(85)/Q(83) = 1{\cdot}66 \pm 0{\cdot}10$. G. E. Brown

539.152.2 : 545.8

Quantitative analysis by nuclear magnetic absorption. *See Abstr.* 7483

539.153

7293. A method of accurate determination of absolute values of X-ray levels in copper. II (6). M. Satô. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **7**, *No.* 1, 56–66 (*Feb.*, 1955).

From the analysis of the optical absorption spectrum of copper thin films observed by Smakula (1933), the absolute value of the energy level E_2 was determined. Then, the absolute values of the others, K, L_I, L_{II}, L_{III}, M_I, M_{II}, M_{III}, M_{IV}, M_V, E_1, E_3 and E_4, were determined by combinations. E_1, E_2, E_3 and E_4 are the energy levels associated with the valence electrons. A.

539.153

7294. Electronegativity and some univalent elements. D. Chapman. *Research* Correspondence, **8**, *No.* 3, S12 (*March*, 1955).

Comparison of thermochemical and Mulliken scale electronegativities for Cu, Ag, Au, Tl, suggests that the mode of application of the latter scale to elements with *d*-orbitals needs re-examination. J. Hawgood

539.153

7295. The energy levels of atoms with atomic number less than 70. Y. Cauchois. *J. Phys. Radium*, **16**, *No.* 4, 253–62 (*April*, 1955) In French.

A critical compilation from X-ray data for the elements $Z = 3$–69 inclusive, which supplements the previous list for the heavy elements [Abstr. 5989 (1952)]. J. Hughes

539.153

7296. Energy levels in the ground terms of the ions A XIII–Ti XVII. D. Layzer and H. Zirin. Note in *Astrophys. J.*, **121**, *No.* 3, 771–2 (*May*, 1955).

Predicted wavelengths and transition probabilities are listed for A XIII, K XIV, Ca XV, Sc XVI and Ti XVII, computed by the aid of atomic parameters based partly on Garstang's semi-empirical values (1951). The predictions may prove useful in the identification of several unclassified coronal emissions. D. R. Barber

539.153

7297. Application of nuclear coincidence methods to atomic transitions in the wavelength range λλ 2 000–6 000 A. E. Brannen, F. R. Hunt, R. H. Adlington and R. W. Nicholls. Letter in *Nature* [*London*] **175**, 810–11 (*May* 7, 1955).

Describes coincidence methods of measuring the lifetimes of excited states, using photomultiplier

tubes. Other possible applications of the method (e.g. to the measurement of relative transition probabilities) are enumerated. The lifetime of the 7^3S_1 state of mercury was found to be $1{\cdot}12 \pm 0{\cdot}02 \times 10^{-8}$ sec. J. D. CRAGGS

539.153 : 535.332

7298. Two-configurational approximation for two low-lying configurations of boron. G. K. TSYUNAĬTIS AND A. P. YUTSIS. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 452–7 (1955) In Russian.

Calculations are for the two basic configurations $1s^22s^22p$ and $1s^22s^23p$; the two mixed configurations are $1s^22s^22p^k3s^{1-k}(k = 1, 0)$. Numerical values for the wave-functions, energy, transition probabilities, etc., are given. G. E. BROWN

539.153 : 535.338.333

An approximation method for determining the screening effect from the isotope shift of spectral lines. *See Abstr.* 6904

539.153 : 537.561

7299. Approximate calculation of cross-sections for atomic photoionization. I. The use of hydrogen-like wave-functions for the continuous states. M. J. SEATON. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 11, 1193–5 (*March* 14, 1955) In French.

The wave-functions of Abstr. 4640 (1949) were used for the stationary states and H-like functions for the continuum. Short tables of cross-sections are given for various values of the effective principal quantum number. Comparison with other calculations for transitions of the type $np \rightarrow kd$ are given for Na, Mg^+ and Si^+. W. J. SWIATECKI

539.153 : 537.561

7300. Approximate calculation of cross-sections for atomic photoionization. II. A relation between the quantum defect and the phase of the wave-function at the spectral limit. M. J. SEATON. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1317–8 (*March* 21, 1955) In French.

The relation $\pi\mu = \delta$ is derived, where μ = quantum defect at a series limit and δ is the asymptotic zero energy phase shift of the actual wave-function with respect to a hydrogen-like one. The relation is confirmed by a comparison of four observed $\pi\mu$ values and corresponding δ's calculated by the Hartree–Fock method. W. J. SWIATECKI

539.153.4

7301. A clear picture [anschauliche Deutung] of the fine structure anomaly in positronium. W. HUMBACH. Note in *Z. Naturforsch.*, **10a**, *No.* 4, 347 (1955) In German.

The approximate magnitude of the "virtual annihilation" δ-function contribution is obtained by a simple picture in which annihilation and rematerialization cause a fluctuation in the position of the electron of order $\hbar/mc$. G. E. BROWN

539.153.4

7302. On the distribution of angular momentum in the statistical model of the atom. S. I. LARIN. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 498–501 (1955) In Russian.

The mean square orbital momentum $\bar{L}^2 = (1/Z)\int L^2 n(L)\alpha L$ is calculated as a function of Z for a Fermi–Thomas atom with and without corrections for exchange. G. E. BROWN

539.153.4

7303. An improved approximate analytic solution of the Thomas–Fermi equation for atoms. T. TIETZ. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 955–6 (*May*, 1955).

Using the value of Umeda's minimization integral $I(\Phi)$ [Abstr. 9522 (1954)] as a criterion for the goodness of an approximate solution $\Phi(x)$, it is shown that $\Phi(x) = a^2/(x + a)^2$ is better than either Kerner's $(1 + Cx)^{-1}$ [Abstr. 6753 (1951)] or Sommerfeld's $\Phi(x)$. W. J. SWIATECKI

539.153.4

7304. On an approximation to the Fermi distribution for free positive ions. T. TIETZ. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 968–71 (*May*, 1955) In German.

The difference δ between the distribution function Φ for the ion and Φ_0 for the neutral atom is small and when treated as a perturbation obeys to first order a linear differential equation with coefficients dependent on Φ_0 and its second derivative. Using a previous approximate expression for Φ_0 [Abstr. 3983 (1955)], this equation can be solved for δ. G. E. BROWN

539.153.4

7305. Fourth-order radiative corrections to atomic energy levels. II. R. L. MILLS AND N. M. KROLL. *Phys. Rev.*, **98**, *No.* 5, 1489–500 (*June* 1, 1955).

A rigorous method is described for treating the problem of the hydrogen-like atom in quantum electrodynamics by separation of integrals into parts which can be evaluated with relativistic and non-relativistic approximations. The method is based on that developed by Baranger, Bethe and Feynman for the second-order problem, and is applied here to the problem of the fourth-order radiative energy level displacement. It is shown that the result inferred by Weneser, Bersohn and Kroll from the study of fourth-order radiative corrections to elastic scattering by a given external potential is correct to order $\alpha^2(\alpha z)^4mc^2$ for a hydrogenic atom. It is also shown that the αZ corrections to this result can be obtained using this method, just as was done in the second-order problem by Baranger, Bethe and Feynman. For previous part, see Abstr. 699 (1954). A.

539.153.4

7306. Atomic wave functions for gold and thallium. A. S. DOUGLAS, D. R. HARTREE AND W. A. RUNCIMAN. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 486–503 (*July*, 1955).

Wave-functions are obtained by a self-consistent field calculation for Au^+. From the known results for Au^+ and Hg^{+2}, extrapolation is used to find the wave-functions of electrons up to the $(5d)^{10}$ group in Tl^{+3}. For the latter group, iteration is carried out until the results are self-consistent. To Tl^{+3} electrons in configurations $(6s)^2$ and $6s6p$ are added and iteration is carried out to provide functions for the ground and excited states, respectively, of Tl^+. G. E. BROWN

539.154.2

7307. The uranides (93–95) and the trans-curium (97–100) elements. C. BEDREAG. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1767–9 (*May* 2, 1955) In French.

The placing of these elements in the periodic table is discussed. J. J. WILKINS

539.154.2 : 539.163 : 539.172.11

New element, mendelevium. *See Abstr.* 7357

539.155.2

7308. On the time-of-flight separator. R. HOFMANN AND W. WALCHER. *Z. Phys.*, **141**, *No.* 1–2, 237–45 (1955) In German.

The effect of space charge on the operation of time-of-flight isotope separators depending on phase focusing is discussed. A time-of-flight arrangement is suggested which is practically independent of phase focusing and so is unaffected by space charge. J. HUGHES

539.155.2

7309. Separation of nitrogen isotopes by chemical exchange between NO and HNO_3. W. SPINDEL AND T. I. TAYLOR. Letter in *J. chem. Phys.*, **23**, *No.* 5, 981–2 (*May*, 1955).

Preliminary single-stage experiments have shown that, for the NO — 10 M HNO_3 proportion, the N^{15} enrichment factor of the reaction $N^{15}O(g) + HNO_3^{14}(aq) \rightleftharpoons N^{14}O(g) + HNO_3^{15}(aq)$ is $1{\cdot}045 \pm 0{\cdot}01$. The exchange column used is illustrated and its operation described. F. LACHMAN

539.155.2

7310. Variation in the natural abundance of the lithium isotopes. A. E. CAMERON. *J. Amer. Chem. Soc.*, **77**, *No.* 10, 2731–3 (*May* 20, 1955).

Lithium samples from commercial and from known mineralogical sources have been investigated and the variation in the Li^7/Li^6 ratio with origin is established. Measurements have been made on the $Li^6Li^7I^+$ and $Li^7Li^7I^+$ ions at masses 141 and 140. Sublimation of the iodide is free from discriminatory effects and no corrections need be applied. This ratio has been shown to be unaffected by variations in instrumental conditions and is believed to be reliable. The variation of Li^7/Li^6 ratio in commercial chemicals has been observed to be between 12·44 and 12·93. Minerals examined show variations in the 7/6 ratio between 12·47 and 12·72. Partial precipitation of lithium as phosphate or carbonate is shown to effect an isotope separation. A.

539.155.2 : 541.135

The isotope effect in the electrolytic migration of potassium ions in molten potassium nitrate. *See Abstr.* 7462

539.155.2 : 541.135

Isotopic enrichment in chlorine by electrolytic transport in molten lead chloride. *See Abstr.* 7463

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

7311. Scintillation techniques for the detection of natural radiocarbon. B. L. FUNT, S. SOBERING, R. W. PRINGLE AND W. TURCHINETZ. Letter in *Nature* [*London*] **175**, 1042–3 (*June* 11, 1955).

A liquid scintillator system incorporating the sample carbon in the form of the solvent (toluene) and protected from γ- and cosmic-ray counts showed a counting efficiency of ~50%. Significant results are obtainable with samples of age up to 45 000 yr, using sample volumes of ~20 cm^3 and a counting period of 2 days. A. O. STANESBY

539.16.08 : 578.088.5

7312. Application of scintillators to the determination of distributions of radioactive material *in vivo*. C. KELLERSHOHN AND P. PELLERIN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1816–8 (*May* 2, 1955) In French.

Two lead grids 18 mm thick drilled with closely spaced holes 1·5 mm diameter containing NaI crystals, are placed one on either side of a photographic film, so that an intensified image is reproduced of the γ-ray distribution of active material in an adjacent body. The method allows distribution measurements of I^{131} in the thyroid to be made with 12 μC per cm^3 of tissue in 8 minutes exposure. F. T. FARMER

539.162

7313. Simplified procedure for computing the growth of radioactive decay products. H. W. KIRBY AND D. A. KREMER. *Analyt. Chem.*, **27**, *No.* 2, 298–9 (*Feb.*, 1955).

A method is described for easing the burden of computing equations for the growth of radioactive decay products. A sample table and a sample calculation are included. A.

539.163

7314. Nuclear properties of 100^{256}. G. R. CHOPPIN, B. G. HARVEY, S. G. THOMPSON AND A. GHIORSO. Letter in *Phys. Rev.*, **98**, *No.* 5, 1519–20 (*June* 1, 1955).

The nuclide 100^{256} was made by neutron irradiation of 99^{255} in the Materials Testing Reactor. About 20 spontaneous fission events were attributed to 100^{256}, the spontaneous fission ½-life being about 3–4 hr; the ratio α-particle-emission/spontaneous-fission ~0·04. A. O. STANESBY

539.163 : 539.154.2 : 539.172.11

New element, mendelevium, decaying by spontaneous fission. *See Abstr.* 7357

539.163 : 539.165 : 539.172

7315. Probability of spontaneous fission and β-stability. N. N. KOLESNIKOV AND S. I. LARIN. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 244–5 (1955) In Russian.

A plot of log τ (half-life for spontaneous fission) *v.* Z^2/A for 18 even-even nuclides of Z from 90 to 100 is evidence that "the maximum of stability against spontaneous fission coincides sufficiently accurately with the maximum stability against β-decay." An empirical formula connecting log τ, A^* (mass number of maximum stability against β-decay for a given element), Z and A gives an approximately linear relation between Z^2/A^* and log τ. S. DEDIJER

539.163.1

7316. Measurement of the period of Ra*D*. J. TOBAILEM. *J. Phys. Radium*, **16**, *No.* 3, 235–6 (*March*, 1955) In French.

The decay of Ra*D* was followed over a period of

121 days using a differential arrangement of two ionization chambers [Abstr. 3999 (1955)]. The $\frac{1}{2}$-life was $19 \cdot 40 \pm 0 \cdot 35$ yr. A. O. STANESBY

539.163.2

7317. On the decay of ^{134}Cs. G. BERTOLINI, M. BETTONI AND E. LAZZARINI. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 4, 746–8 (*April*, 1955).

Preliminary report of β-γ-coincidence measurements using an intermediate image β-spectrometer and a NaI(Tl) crystal γ-spectrometer. A decay scheme is proposed. A. O. STANESBY

539.163.2

7318. On the radiations emitted during the transmutation RAc → AcX. II. M. FRILLEY, S. ROSENBLUM, M. VALADARES AND G. BOUISSIÈRES. *J. Phys. Radium*, **16**, *No.* 5, 378–84 (*May*, 1955) In French.

For Pt I, see Abstr. 3792 (1954). Measurements of the conversion spectrum have been extended to cover γ-ray energies up to 335 keV. The polarities of the γ-rays are determined, and a level scheme of AcX, consistent with the known α, γ and conversion spectra, is given. J. J. WILKINS

539.163.2

7319. Radiations of I^{126}. L. KOERTS, P. MACKLIN, B. FARRELLY, R. VAN LIESHOUT AND C. S. WU. *Phys. Rev.*, **98**, *No.* 5, 1230–7 (*June* 1, 1955).

The β and γ radiations and the electron capture process of I^{126} have been thoroughly investigated. The β^- branch consists of three groups of maximum energies 1·25, 0·865 and 0·385 MeV. The relative intensities of these three β^- groups are $1 : 3 \cdot 1 : 0 \cdot 63$ respectively. The shape of the highest energy β^- group identifies the ground to ground transition to be a unique first forbidden one ($\Delta J = 2$, yes). The spectrum of the middle β^- group as measured by the magnetic coincidence spectrometer has an allowed shape. The number of β^+ disintegrations is only 2·8% of that of the β^- disintegration. Two groups of maximum energies 1·11 and 0·46 MeV were found with an intensity ratio of $3 \cdot 5 : 1$. The shape of the β^+ spectrum of the ground to ground transition is also the unique first forbidden type. The correlations among the various γ lines and X-line and their relative intensities are determined by a selective coincidence scintillation spectrometer. In conclusion, the spin and parity of the I^{126} ground state is definitely 2^- and its decay scheme is in general agreement with that of Perlman and Welker. A.

539.163.2

7320. Radionuclides Al^{24}, P^{28}, Cl^{32}, and Sc^{40}. N. W. GLASS AND J. R. RICHARDSON. *Phys. Rev.*, **98**, *No.* 5, 1251–7 (*June* 1, 1955).

Three new short-lived positron emitters, P^{28}, Cl^{32} and Sc^{40}, of the nuclear series $Z = 2n + 1$, $A = 4n$ have been produced by p-n reactions using 20 MeV protons from the UCLA 41 in. FM cyclotron. Al^{24} has also been investigated. Al^{24} has a half-life of $2 \cdot 10 \pm 0 \cdot 04$ sec and five γ-rays from 1·39 MeV to 7·12 MeV. 2 MeV α-particles are emitted in a small fraction of the decays. P^{28} has a half-life of $0 \cdot 280 \pm 0 \cdot 010$ sec, threshold of $15 \cdot 6 \pm 0 \cdot 5$ MeV, eight γ-rays from 1·79 MeV to 7·59 MeV, and positrons of maximum energy $10 \cdot 6 \pm 0 \cdot 4$ MeV. No heavy particles were detected in the decay. Cl^{32} has a half-life of $0 \cdot 306 \pm 0 \cdot 004$ sec, threshold of $14 \cdot 3 \pm 0 \cdot 5$ MeV, four γ-rays from 2·21 MeV to 4·77 MeV and positrons of maximum energy $9 \cdot 5 \pm 0 \cdot 4$ MeV. 2–3 MeV α-particles are emitted in a small fraction of the decays. Sc^{40} has a half-life of $0 \cdot 22 \pm 0 \cdot 03$ sec, threshold of $15 \cdot 9 \pm 1 \cdot 0$ MeV, a $3 \cdot 75 \pm 0 \cdot 04$ MeV γ-ray and maximum positron energy of $9 \cdot 0 \pm 0 \cdot 4$ MeV. No heavy particles were detected in the decay. Possible decay schemes can be set up which involve favoured positron transitions to calculated analogue levels in the daughters in the cases of Al^{24}, P^{28} and Cl^{32}. In the P^{28} decay, the positron component to the 1·78 MeV level in Si^{28} has the same *ft* value as the negatron decay to this level from Al^{28}, thus indicating the similarity of the nuclear wave-functions of P^{28} and Al^{28}. A.

539.163.2

7321. *K* and *L* X-ray intensities in cesium-131 decay. R. W. FINK AND B. L. ROBINSON. *Phys. Rev.*, **98**, *No.* 5, 1293–6 (*June* 1, 1955).

A measurement of the relative intensities of the *K* and *L* X-rays following electron-capture in Cs^{131} is reported. The result may be expressed $[L_I/K + L_{II,III}/K + n]\bar{\omega}_L = 0 \cdot 106 \pm 0 \cdot 008$, where L_I/K is the ratio of L_I-shell capture to *K*-shell capture, n is the probability of an *L*-ionization following a *K*-vacancy, and $\bar{\omega}_L$ is the mean *L*-fluorescence yield of xenon. Upon combining this with recent theoretical results on electron-capture, the mean value of the *L*-fluorescence yield of xenon is found to be $0 \cdot 10_3 \pm 0 \cdot 01$. This value is suggested as a normalization point for the relative photographic values of $\bar{\omega}_L$ in the region $Z = 54$. In order to explain the observed anomalies in inner bremsstrahlung spectra of electron-capture on the basis of *p*-electron capture, one must conclude that L_{II}-capture is considerably more radiative than L_I-capture, and, furthermore, that the probability of radiative capture increases more strongly than Z for L_{II}-capture than for L_I-capture. Traces of 6·2-day Cs^{132} and 13·6-day Cs^{136} were found in the first caesium fraction from pile-irradiated barium nitrate, presumably induced by (n, p) reactions. A.

539.164

7322. α-Particle spectra. S. ROSENBLUM. *Cahiers de Phys.*, *No.* 53, 38–44 (*Jan.*, 1955) In French.

A brief historical review. A. O. STANESBY

539.164

7323. Development of α-activity in a source of Actinium K (Fr^{223}). J.-P. ADLOFF. *C.R. Acad. Sci. [Paris]* **240**, *No.* 13, 1421–3 (*March* 28, 1955) In French.

The growth of AcX from AcK with a period of 22 ± 1 min has been observed by following the α-activity of a source of AcK using nuclear emulsions. Further measurements confirm the closing of the two branches ($\alpha/\beta \sim 6 \times 10^{-5}$) of the Ac → AcX cycle and show that the energy of the AcK α-particles is $5 \cdot 34 \pm 0 \cdot 08$ MeV. M. A. GRACE

539.165

7324. Some preliminary results on the absolute beta counting of tritium. R. C. HAWKINGS AND W. F. MERRITT. *Atomic Energy Canada Rep.*, *No.* 94, 4 *pp.* (*Jan.*, 1954).

A brief description is given of the standardization

of a H^3 source using a proportional counter. The values of source strength are in agreement (1–2%) with those obtained by other methods. M. A. GRACE

539.165

7325. Study of the components of the β^- spectrum of Rb^{86}_{37}. J. LABERRIGUE-FROLOW AND M. LEDERER. Letter in *J. Phys. Radium*, **16**, *No.* 4, 346–7 (*April*, 1955) In French.

β and β-γ coincidence spectra have been obtained from thin sources of Rb purified by paper chromatography. The 730 keV spectrum is very nearly of allowed form. J. J. WILKINS

539.165

7326. First-forbidden nonunique beta spectra in Re^{186}. F. T. PORTER, M. S. FREEDMAN, T. B. NOVEY AND F. WAGNER, JR. Letter in *Phys. Rev.*, **98**, *No.* 1, 214–15 (*April* 1, 1955).

β-γ-coincidence experiments indicate that the two β-component Kurie plots show downward deviations at the lower energies; the only spin assignment for Re^{186} consistent with this and the β-γ-angular anisotropy is 1—. A. O. STANESBY

539.165

7327. Positron emission from Np^{234}. R. J. PRESTWOOD, H. L. SMITH, C. I. BROWNE AND D. C. HOFFMAN. *Phys. Rev.*, **98**, *No.* 5, 1324 (*June* 1, 1955).

An investigation of Np^{234} with a trochoidal analyser revealed the presence of positrons having an end-point energy of approximately 0·8 MeV. The ratio of positron emission to electron capture was found to be $(4{\cdot}6 \pm 1{\cdot}0) \times 10^{-4}$. A.

539.165.2

7328. Quasi-linearity of the energy of the β-transitions between the heavy radioactive elements. F. ROGER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1338–9 (*March* 21, 1955) In French.

Empirical expressions are given relating in a linear manner the neutron and proton numbers of the nuclei and the maximum energy of the β-transition between them. The relations are used to predict the β-stability of certain isotopes of the transuranic elements. J. HUGHES

539.166

7329. The emission of photoelectrons from the *K*-shell in the direction of the liberating γ-ray. F. SAUTER AND H. O. WÜSTER. *Z. Phys.*, **141**, *No.* 1–2, 83–6 (1955) In German.

The results of the calculation of the angular distribution of the electrons from the *K*-shell are given for the relativistic region. A finite intensity in the direction of the incident γ-radiation is predicted, in agreement with recent experiments [Abstr. 7700 (1954)]. J. HUGHES

539.166

7330. Fast coincidence and γ-γ spectroscopy with NaI(Tl) scintillation counters; the application to Rh^{102}. I. L. DICK, R. FOUCHER, N. PERRIN AND H. VARTAPETIAN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 12, 1335–7 (*March* 21, 1955) In French.

A fast-slow coincidence set has been tested by measuring the mean life of the 480 keV state in Ta^{181} $(1{\cdot}0 \times 10^{-8}$ sec) and used to study the γ-radiation in the decay of Rh^{102}. The 125 and 195 keV γ-rays and the *K* X-rays are all in coincidence and it is concluded that *K*-capture accounts for 80% of the disintegrations. M. A. GRACE

539.166

7331. Gamma rays in the decay of Na^{25}. J. E. IWERSEN AND W. S. KOSKI. *Phys. Rev.*, **98**, *No.* 5, 1307 (*June* 1, 1955).

Studies of the γ-ray spectrum of Na^{25} with a scintillation spectrometer showed that γ's with energies of 0·98, 0·59, 0·41 and possibly 0·46 MeV were associated with the decay. The first three γ-rays are compatible with existing energy levels in Mg^{25}. A.

539.166 : 539.172.13

7332. Gamma rays from the low-energy proton bombardment of beryllium. R. R. CARLSON AND E. B. NELSON. *Phys. Rev.*, **98**, *No.* 5, 1310–15 (*June* 1, 1955).

The γ-radiation produced in the $Be^9(p, \gamma)B^{10}$ reaction at proton energies of approximately 300 keV was investigated with scintillation spectrometers. A three-crystal scintillation spectrometer detected $6{\cdot}7 \pm 0{\cdot}15$, $6{\cdot}0 \pm 0{\cdot}1$, $5{\cdot}1 \pm 0{\cdot}1$ and $4{\cdot}7 \pm 0{\cdot}15$ MeV γ-rays with relative intensities ($\pm 25\%$) of 0·15, 0·40, 1·00 and 0·45 respectively. A thick target yield of $(1{\cdot}2 \pm 0{\cdot}3) \times 10^{-10}$ γ per proton at 315 keV proton energy was measured for γ-radiation of 5·1 MeV energy. These γ-rays are produced in transitions to the ground-state and low-lying levels in B^{10} and their relative intensities and yield imply spin 1^- for the level at 6·89 MeV. A limited single-crystal spectrometer detected $0{\cdot}41 \pm 0{\cdot}02$, $0{\cdot}72 \pm 0{\cdot}02$, $1{\cdot}03 \pm 0{\cdot}03$ and $1{\cdot}43 \pm 0{\cdot}03$ MeV γ-rays corresponding to transitions between the low-lying levels in B^{10}. The angular correlation of the 0·72 and 1·03 MeV γ-rays was found to be consistent with a spin of 1^+ or 2^+ for the first excited state of B^{10}. A.

539.166 : 537.531

7333. Study of γ and X radiations emitted by actinium. R. BOUCHEZ, A. MICHALOWICZ, M. RIOU and J. TEILLAC. Letter in *J. Phys. Radium*, **16**, *No.* 4, 344–5 (*April*, 1955) In French.

Scintillation spectrometer measurements indicate rays at 13, 33, 50 and 80 keV, attributed respectively to Ac, La (*K*-radiation), AcK + RAc and AcK. J. J. WILKINS

539.166 : 539.152.1

7334. Spin and lifetime of the 439-keV excited state of Hg^{202}. F. R. METZGER. Letter in *Phys. Rev.*, **98**, *No.* 1, 200–1 (*April* 1, 1955).

Using a source of Tl^{202} at 1 000°c, nuclear resonance fluorescence from the 439 keV excited state of Hg^{202} was observed, and the calculated life-time of this excited state was $(3{\cdot}4 \pm 0{\cdot}7) \times 10^{-11}$ sec. The angular distribution of the resonance radiation was also measured, using a gaseous source of thallium iodide; it is consistent with a spin assignment of 2 for the excited state. A. O. STANESBY

539.166.08

7335. Spurious peaks due to multiple backscattering in a single crystal gamma spectrometer. A. Bisi, L. Zappa and E. Germagnoli. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1120–5 (*June*, 1955).

The energy spectra obtained with a single crystal spectrometer for γ-rays have been investigated in detail in the energy range between 50 and 300 keV. Several γ sources have been used. Evidence is given of some effects due to backscattering of γ-rays from the materials surrounding the crystal. The influence of this effect upon the reliability of the spectrometer in the considered interval of energy is discussed. A.

539.166.74

7336. Measurement of the cross-section and the energy spectrum in the double Compton effect. A. Bracci, C. Coceva, L. Colli and R. D. Lonati. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 4, 752–5 (*April*, 1955).

These were measured for Co^{60} γ-rays scattered in Be, the simultaneous γ-ray pairs scattered at 90° to themselves and to the incident radiation being detected by crystal spectrographs. The cross-section found was $\sim 4\times10^{-30}$ cm^2.steradian^{-1}, and the energy spectrum is in agreement with that calculated theoretically. A. O. STANESBY

539.166.74

7337. The angular distribution of multiply-scattered γ-radiation. B. W. Soole. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 343–53 (*June* 21, 1955).

The intensity of ionization up to a distance of 400 yards (2½ mean free paths) in air from a forward-emitting 500 curie source of Co^{60} has been measured using air-filled condenser integrating ion chambers with air equivalent walls. These chambers have been used unshielded, and also shielded by lead cones cutting off all radiation within $\pm5°$ of the main beam and within increasing angles up to $\pm90°$. It has been found that of the total, unshielded dose, 25% is due to scattered radiation arriving over angles outside $\pm5°$ of the main beam at 100 yards, with a corresponding figure of 52% at 400 yards. Back-scattered radiation accounts for 5% of the dose at 100 yards and 10% at 400 yards. Figures for intermediate angles and distances are also given. It appears possible that equilibrium is reached at about 600 yards (4 mean free paths) with values only slightly above those quoted for 400 yards. A.

539.166.79

7338. Monte Carlo calculation of gamma-ray albedos of concrete and aluminum. J. F. Perkins. *J. appl. Phys.*, **26**, *No.* 6, 655–8 (*June*, 1955).

Number and energy γ-ray albedos have been calculated for a material of $Z_{\text{eff}} = 13$, corresponding to both concrete and aluminium. The Monte Carlo method was used, the calculations being performed on an IBM–701. The single- and multiple-scattered components were evaluated separately; the multiple-scattered component was considerably the larger of the two in most cases, being as much as three times as large as the single-scattered component. For moderately small incident angles, the emergent photons are distributed approximately proportional to the cosine of the normal angle of emergence. The spectra peak around 150–250 keV and in some cases have a second peak at higher energy; such secondary peaks move upward in energy and increase in importance as the angle of incidence increases. The average energy of the emergent photons varies from $0{\cdot}33$ to $1{\cdot}4m_0c^2$. For multiple-scattered component the average energy varies from $0{\cdot}30$ to $0{\cdot}93m_0c^2$. Buildup factors have been calculated for $2m_0c^2$ γ's normally incident on aluminium of 2 and 4 free paths thickness. A.

539.166.83

7339. Internal conversion radiation of radium. M. K. Jurić and D. M. Stanojević. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 15–18 (*March*, 1955).

The value of $K(L + M + N)$ ratio was determined for electrons of the internal conversion due to the fine structure of α-rays. The result obtained indicates that this transition is an electric quadrupole. A.

539.166.83

7340. *K*-shell internal conversion coefficients. R. C. Rohr and R. D. Birkhoff. *Phys. Rev.*, **98**, *No.* 5, 1266–7 (*June*, 1955).

Internal conversion coefficients for the *K*-shells of several medium energy γ emitters have been measured with a solenoidal β-spectrometer and a 30 mg/cm^2 lead radiator. Isotopes investigated, with γ-energies and conversion coefficients $\times10^3$, are as follows: Nb^{95}, 722 keV, $1{\cdot}6 \pm 0{\cdot}8$; Cd^{110}, 657 keV, $2{\cdot}2 \pm 0{\cdot}8$; Te^{122}, 570 keV, $6{\cdot}6 \pm 1{\cdot}7$; La^{140}, 541 keV, $5{\cdot}6 \pm 1{\cdot}9$; Ce^{140}, 489, $5{\cdot}3 \pm 2{\cdot}0$. These values lead to multipolarity assignments of $E2$ or $M1$ for the first three, $E2$ for the La^{140} and $E1$ or $E2$ for the Ce^{140}. A.

539.166.83

7341. Threshold values of internal conversion coefficients for the *K*-shell. B. I. Spinrad. *Phys. Rev.*, **98**, *No.* 5, 1302–4 (*June* 1, 1955).

Corrected relativistic calculations for the internal conversion coefficients of *K*-shell electrons at threshold energies of the γ-rays are presented. A comparison is made with nonrelativistic formulae. A.

539.166.835

7342. Pair emission from P^{32}. A. B. Milojević and V. Z. Wintersteiger. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 19–22 (*March*, 1955).

The annihilation radiation from P^{32} has been measured by the slow-fast coincidence method, with a resolving time of 5×10^{-8} sec. The result obtained is less than $1{\cdot}3\times10^{-7}$ positrons per β-disintegration, which is in agreement with the theory of internal pair formation by the β-particles. A.

539.166.835

7343. Angular correlation in two-photon annihilation in quartz. L. A. Page, M. Heinberg, J. Wallace and T. Trout. Letter in *Phys. Rev.*, **98**, *No.* 1, 206–8 (*April* 1, 1955).

A narrow component was found in the angular correlation of 2-quantum positron annihilation radiation in fused quartz at room temp.; crystalline quartz does not show this anomaly. A. O. STANESBY

539.166.835

7344. Pair spectrometer measurements of the radiations from excited states of light nuclei. R. D. Bent, T. W. Bonner and R. F. Sippel. *Phys. Rev.*, **98**, *No.* 5, 1237–44 (*June* 1, 1955).

A magnetic-lens pair spectrometer has been used to study the radiations produced by the bombardment of certain light nuclei with protons and deuterons from a Van de Graaff accelerator. γ-rays from the bombardment of F^{19} with 3·7 MeV protons were observed at 6·10 ± 0·04 and 6·99 ± 0·04 MeV. At 4·7 MeV bombarding energy, no lines were observed between 7·5 and 11·0 MeV with an intensity as great as 10% of that of the 6·99 MeV line. γ-rays from the bombardment of C^{13} with 2·0 MeV deuterons were observed at 3·42 ± 0·03, 3·71 ± 0·05, 3·94 ± 0·06, 4·48 ± 0·04, 4·96 ± 0·03, 5·12 ± 0·04, 5·74 ± 0·03, 6·14 ± 0·03, 6·53 ± 0·05 and 6·72 ± 0·03 MeV. At 4·0 MeV bombarding energy, lines were observed at 6·14 ± 0·03, 6·53 ± 0·04, 6·72 ± 0·03, 7·09 ± 0·03 and 7·34 ± 0·04 MeV. γ-rays from the bombardment of C^{12} with 4·0 MeV deuterons were observed at 3·76 ± 0·02 and 3·86 ± 0·02 MeV. No lines were observed between 3·86 and 5·8 MeV with an intensity as great as 10% of that of the 3·86 MeV line. All the energies of γ-rays given above are uncorrected for Doppler shifts which in some cases are as large as 40 keV. A search was made for nuclear pairs which might originate from the proton bombardment of B^{11}. No pairs were observed at 4·0 MeV bombarding energy in the energy range between 6·5 and 9·5 MeV. A search was also made for nuclear pairs which might result from the $Li^7(d, n)Be^8$ reaction. No pairs were observed in the energy range between 5·0 and 8·5 MeV. A.

539.166.835

7345. Nuclear pairs from the 3·4-MeV state in Ca^{40}. R. D. Bent, T. W. Bonner and J. H. McCrary. *Phys. Rev.*, **98**, *No.* 5, 1325–6 (*June* 1, 1955).

A thick calcium metal target was bombarded with 4·84 MeV protons and a search was made with a magnetic lens pair spectrometer for pairs from the 3·35 MeV state of Ca^{40}. A peak was observed in the spectrometer at an energy of 3·46 ± 0·1 MeV. In a second experiment with a 1 mm Al absorber between the calcium target and a 2-mil lead convertor, no external pair peak was observed, indicating that the pairs coming from the target were nuclear pairs and not internally converted γ-ray pairs. The existence of pairs and the absence of γ-radiation establish the angular momentum of the first excited state of Ca^{40} as zero. A.

539.166.835

7346. Internal pair production associated with the emission of high-energy gamma rays. N. M. Kroll and W. Wada. *Phys. Rev.*, **98**, *No.* 5, 1355–9 (*June* 1, 1955).

The theory of inner pair production associated with the radiative capture of π^- mesons and with the decay of the π^0 meson is discussed. Appropriate distribution functions are derived and compared with recently obtained experimental results. The weak dependence of the theoretical predictions upon the details of meson theory is emphasized. The possible utility of the double conversion process, in which the π^0 meson decays into two electron-positron pairs, for the determination of the π^0 parity is also discussed. A.

539.166.835

7347. Positronium formation in gases and its pressure dependence. C. B. O. Mohr. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 4, 342–4 (*April*, 1955).

A Monte Carlo type calculation was used to find the fractions of positrons which annihilate from the free state or from ortho- or para-positronium when they pass through atomic hydrogen at pressures from 0·003 to 30 atm. W. J. Swiatecki

539.166.835

7348. Static magnetic field quenching of the ortho-positronium decay: angular distribution effect. V. W. Hughes, S. Marder and C. S. Wu. *Phys. Rev.*, **98**, *No.* 6, 1840–8 (*June* 15, 1955).

An effect of the angular dependence of the annihilation radiation from the magnetic substates of ortho-positronium has been observed in an experiment similar to that of Deutsch and Dulit. Quanto due to positron annihilations were observed at a direction of 90° to a magnetic field. The fraction, f, of ortho-positronium decaying by three quantum annihilation can then be computed, and at high values of the field f was found to be less than $\frac{2}{3}$. The value $\frac{2}{3}$ is expected statistically since only annihilation radiation of the $M = 0$ substate is affected by the field. This observation is understandable if Drisko's formulae for the angular distribution of the annihilation radiation from different magnetic substates are considered. The ratio of the decay rates of parapositronium to orthopositronium can be computed from values of f *v.* the field, after corrections are made for the angular distribution of the quanta. The data yield $\lambda_p/\lambda_0 = 1302$ with a probable error of ±15%, in agreement with the theoretical value of 1114. A.

539.167.3

7349. Preparation and half life of carrier-free yttrium-90. M. L. Salutsky and H. W. Kirby. *Analyt. Chem.*, **27**, *No.* 4(I) 567–8 (*April* 25, 1955).

A rapid method was needed for obtaining a continual supply of carrier-free yttrium-90. The lack of agreement among the reported half-life values indicated that a precise determination of the half-life of yttrium-90 would be desirable. Carrier-free yttrium-90 was "milked" periodically from a purified strontium-90 sample by precipitation of the strontium-90 with strontium nitrate carrier in 80% nitric acid. The half-life, determined by β-counting, was found to be 64·029 ± 0·024 hr. By use of the recommended procedure high-purity yttrium-90 with yields of 95% is available when needed for an indefinite period of time. A.

539.167.3

7350. Radiochemical study of neutron-deficient chains in the noble metal region. W. G. Smith and J. M. Hollander. *Phys. Rev.*, **98**, *No.* 5, 1258–66 (*June* 1, 1955).

A radiochemical study of some neutron-deficient nuclides in the noble metal region has been undertaken, and several new chains identified. The method used to establish genetic relationships was that of

timed chemical separations, where the parent activities are initially produced by cyclotron or linear accelerator bombardments. The following chains have been identified:

$$A = 191: \mathrm{Hg^{191}} \xrightarrow{55\,\mathrm{min}} \mathrm{Au^{191}} \xrightarrow{3{\cdot}0\,\mathrm{hr}} \mathrm{Pt^{191}} \xrightarrow{3{\cdot}0\,\mathrm{day}} \mathrm{Ir^{191}},$$

$$A = 189: \mathrm{Hg^{189}} \xrightarrow{\sim 20\,\mathrm{min}} \mathrm{Au^{189}} \xrightarrow{42\,\mathrm{min}} \mathrm{Pt^{189}} \xrightarrow{10{\cdot}5\,\mathrm{hr}} \mathrm{Ir^{189}} \xrightarrow{11\,\mathrm{day}(?)} \mathrm{Os^{189}},$$

$$A = 188: \mathrm{Pt^{188}} \xrightarrow{10{\cdot}0\,\mathrm{day}} \mathrm{Ir^{188}} \xrightarrow{41\,\mathrm{hr}} \mathrm{Os^{188}},$$

$$A = 187: \mathrm{Au^{187}} \xrightarrow{\sim 15\,\mathrm{min}} \mathrm{Pt^{187}} \xrightarrow{2{\cdot}5\,\mathrm{hr}} \mathrm{Ir^{187}} \xrightarrow{14\,\mathrm{hr}} \mathrm{Os^{187}}.$$

A.

NUCLEAR REACTIONS 539.17

539.17 : 539.152.1

7351. High-energy reactions and the evidence for correlations in the nuclear ground-state wave function. K. A. Brueckner, R. J. Eden and N. C. Francis. *Phys. Rev.*, **98**, *No.* 5, 1445–55 (*June* 1, 1955).

High-energy nuclear reactions which depend strongly on nucleon position correlations in the nuclear ground state are analysed and shown to give evidence for the existence of marked correlation effects. The following high-energy experiments are considered: nuclear photoeffect, meson absorption in nuclei, deuteron pickup, proton–proton scattering in a nucleus and meson production in proton–nucleus collisions. The corresponding cross-sections depend on a nucleon momentum distribution which can be represented at high energies by a single function giving reasonable agreement with all the experiments considered. This momentum distribution differs substantially from that for the shell model of the nucleus and thus provides strong evidence for correlation in the nuclear ground-state wave-function. The transformation methods developed in previous papers are used to provide a unified theory of the above five processes. The momentum distribution predicted by this theory is estimated by two methods, each of which gives close agreement with the experimentally determined function in the relevant energy ranges. A.

539.172

7352. A statistical theory of artificial nuclear reactions. P. Jauho. *Ann. Acad. Sci. Fennicae A I, No.* 186, 10 *pp.* (1955).

A purely statistical theory of Bohr's compound nucleus model is presented. A formula $\delta = D^2/E \simeq 1$ is derived for the ratio of the mean square deviation to the mean value for disintegrations through a chosen channel initiated with n bombarding particles of any kind but leading to the same compound nucleus. This formula can occasionally be checked experimentally and is then recognizable as the square root of $E/\bar{\lambda}_n$) law, whose approximate validity is thus shown to follow from Bohr's assumptions. A.

539.172

7353. The excitation of nuclei by charged particles. J. Prentki. *Cahiers de Phys., No.* 55, 37–52 (*March*, 1955) In French.

The various theories which have been developed for this process are reviewed, the experimental results given and a comparison between theory and experiment made. 24 references are given. J. HUGHES

539.172

Nuclear reactions due to cosmic rays. *See also under* "Cosmic rays." Decimal classification 537.591.8

539.172

7354. Nuclear interaction of K mesons. A. Husain and E. Pickup. Note in *Canad. J. Phys.*, **38**, *No.* 5, 260–2 (*May*, 1955).

Discusses three K-mesons observed in 600μ stripped emulsions exposed at 95 000 ft. One of these comes to rest without giving any detectable decay product or absorption star and it is suggested that it may be an example of nuclear absorption of a K^- with the emission of a neutral particle. Of the other two, one disappears in flight without producing any secondary tracks and the third leaves the emulsion before coming to rest. H. ELLIOT

539.172

7355. π^--Nucleon collisions at 1·5 BeV. W. D. Walker and J. Crussard. *Phys. Rev.*, **98**, *No.* 5, 1416–27 (*June* 1, 1955).

The results of an extensive search for the interactions of 1·5 BeV π^- mesons with nucleons in nuclear emulsion are given. By comparing the cross-section for $\pi^- - P$ interactions in emulsion to the cross-sections as measured by counters, it is deduced that half the "$\pi^- - P$" collisions are collision of π^- with protons on the edge of a nucleus. Arguments are presented to indicate that the basic features of the $\pi^- - P$ interactions are not seriously disguised by the struck nucleons being in a nucleus. The elastic scattering seems to be largely diffraction scattering. Because of the large number of partial waves participating, it is not possible to interpret the differential elastic cross-section unambiguously. However, it seems certain that partial waves at least as high as the F wave participate in the reactions. The angular distribution indicates that the S and P waves are either strongly absorbed or scattered or both. The data seems to be consistent with a nucleon model consisting of a core of about $0{\cdot}5\times10^{-13}$ cm radius plus a field extending out to about $1{\cdot}0\times10^{-13}$ cm. The inelastic collisions have the following features. The nucleons seem to go on the average into the backward hemisphere in the centre-of-mass system after the collision. The more energetic of the two mesons usually goes into the forward hemisphere. The slower meson seems to be fairly closely correlated in angle with the nucleon. In the cases of π^0 production, the π^0 is the fast meson about one-half the time. The production of π^0 and π^+ in $\pi^- - P$ collisions seems to occur with about the same frequency. Also collisions are found which seem to be $\pi^- - N$ collisions. The production of an additional π^0 seems to be the most common process in these collisions. The $\pi^- - N$ collisions seem to be consistent with meson production occurring by means of the production of an excited nucleon in a $T = \frac{3}{2}$ state which

decays with the emission of a meson. The $\pi^- - P$ collisions do not seem to be consistent with such a process since the ratio of the number of π^+ to π^0 productions are not as predicted by theory. Also the Q of decay of such an excited nucleon seems to vary from 50–350 MeV. This would indicate that the excited state lives for such a short time that it may not be a very useful concept. A short summary of the data on stars is also given. A.

539.172.1

7356. The bombardment of chlorine by nitrogen ions. G. W. Greenlees and A. E. Souch. Letter in *Phil. Mag.*, **46**, 682–4 (*June*, 1955).

A target of LiCl was bombarded by N^{14} ions of up to 125 MeV, accelerated in the Birmingham 60 in. cyclotron. Eleven active isotopes were identified, the main yields observed being of Sc^{46}, Sc^{44} and Sc^{44m}, the Sc^{44m} being about half as abundant as the Sc^{44}. Chemical separation followed by half-life and γ-spectrum measurements were used for identification.

J. H. FREMLIN

539.172.11 : 539.163 : 539.154.2

7357. New element mendelevium, atomic number 101. A. Ghiorso, B. G. Harvey, G. R. Choppin, S. G. Thompson and G. T. Seaborg. Letter in *Phys. Rev.*, **98**, *No.* 5, 1518–19 (*June* 1, 1955).

A few atoms of the element with $Z = 101$ (possibly 101^{256}) were obtained and chemically identified. Very intense He ion bombardment of tiny targets of 99^{253} produced a few spontaneously fissionable atoms which elute in the *eka*-Tm position on a cation resin column.

A. O. STANESBY

539.172.11 : 539.172.13 : 539.166

7358. A search for capture processes in alpha-particle and deuteron bombardments. H. R. Allan and N. Sarma. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 535–8 (*June*, 1955).

Attempts were made to detect the process of radiative capture in the α-particle and deuteron bombardment of various target elements, using beams of accelerated particles from a Van de Graaff generator. No definite evidence was obtained for either of these processes, but new upper limits are placed upon the cross-sections. Three methods of detection were employed: a scintillation counter spectrometer, threshold detection and detection of induced radioactivity. A. O. STANESBY

539.172.13

7359. Coulomb excitation of thallium. R. Barloutaud, T. Grjebine and M. Riou. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 11, 1207–10 (*March* 14, 1955) In French.

Thick-target excitation curves and absolute cross-sections were determined for the 205, 280 and 410 keV γ-rays excited by bombardment of $Tl^{203,205}$ by protons.

A. O. STANESBY

539.172.13

7360. Angular distribution of pickup deuterons for 95-MeV protons on carbon, and implications as to internal interactions in carbon. W. Selove. Letter in *Phys. Rev.*, **98**, *No.* 1, 208–10 (*April* 1, 1955).

The angular distribution of the sharp energy group of deuterons observed in this reaction has been analysed by Born-approximation pickup theory, to give the internal momentum distribution of the picked-up neutrons. This shows relatively strong high-momentum components, which indicate the presence of a strong short-range interaction in carbon.

A. O. STANESBY

539.172.13

7361. The yield of $^7Li(p, n)^7Be^*$ neutrons for proton energies between 2·5 and 2·9 MeV. R. Batchelor. Letter in *Proc. Phys. Soc. A*, **68**, *Pt* 5, 452–3 (*May*, 1955).

Using a He^3 neutron spectrometer the relative intensities of the two neutron groups emitted in this reaction were measured as a function of the bombarding energy in this range. The results are presented graphically. J. HUGHES

539.172.13

7362. Millisecond gamma emitter from protons on tantalum. S. D. Softky. *Phys. Rev.*, **98**, *No.* 3, 736–40 (*May* 1, 1955).

A search for γ-emitters in the millisecond range of half-life was conducted, using the 32 MeV Berkeley proton linear accelerator. Foil targets of eighteen common elements were bombarded, and the activity made in them was followed between beam pulses with a gated scintillation counter. The only activity found of measurable yield was from Ta, and it exhibited a half-life of $5{\cdot}5 \pm 0{\cdot}3$ msec. Using a gated nine-channel pulse-height analyser with the NaI(Tl) crystal counter, the excitation curve of this activity was measured and its γ-ray spectrum deduced. γ-rays of 0·35 MeV and 0·22 MeV are indicated by the pulse spectrum, and no β's are present commensurate with this half-life. Comparison of the excitation curve for this activity with those of Ta^{180} (8 h) and W^{179} (30 min) leads to the tentative assignment of this decay to W^{180m}. A.

539.172.13

7363. Energy levels in B^9 and Be^7 from the reactions $C^{12}(p, \alpha)B^9$ and $B^{10}(p, \alpha)Be^7$. J. B. Reynolds. *Phys. Rev.*, **98**, *No.* 5, 1289–92 (*June* 1, 1955).

The energy levels were studied by observation of the α-particle spectra resulting from these reactions. α-groups were observed corresponding to the ground state of B^9 and an excited state at $2{\cdot}39 \pm 0{\cdot}08$ MeV. Groups were observed corresponding to Be^7 being left in the ground state and excited states of the following energies: $0{\cdot}49 \pm 0{\cdot}10$ MeV, $4{\cdot}72 \pm 0{\cdot}08$ MeV, $6{\cdot}27 \pm 0{\cdot}10$ MeV, $7{\cdot}21 \pm 0{\cdot}10$ MeV, $14{\cdot}6 \pm 0{\cdot}3$ MeV. A.

539.172.13 : 539.166

7364. The radiative capture of protons of 669 keV in fluorine. A. B. Clegg, G. A. Jones and D. H. Wilkinson. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 538–9 (*June*, 1955).

The 13·50 MeV γ-ray (radiative width $2{\cdot}2$ eV $\pm$ 15%) of Ne^{20*} has been established as predominantly ($\gtrsim 0{\cdot}9$) $M1$ from angular correlation measurements on the 13·50–1·63 MeV γ-ray cascade from F^{19} bombarded with 669 keV protons. The $M1$ direct ground state transition from the same level was found to have a radiative width $< 0{\cdot}02$ eV. The significant rearrangement in Ne^{20} between the ground and first-

excited states demanded by this striking difference in radiative widths is discussed. A. O. STANESBY

539.172.13 : 539.166

Gamma-rays from the low-energy proton bombardment of beryllium. *See Abstr.* 7332

539.172.13

7365. Angular distribution of protons from the reaction $O^{16}(d, p)O^{17}$. M. K. JURIĆ AND M. M. PETROVIĆ. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 1–6 (*March*, 1955).

The angular distribution of long-range protons from the $O^{16}(d, p)O^{17}$ reaction was observed by bombarding a thin oxygen target with deuterons of the energy $E_d = 0{\cdot}6$, $0{\cdot}8$, $0{\cdot}9$, $1{\cdot}0$, $1{\cdot}1$, $1{\cdot}2$, $1{\cdot}3$ and $1{\cdot}45$ MeV. The coefficients of Legendre polynomials were calculated for the angular distribution curves and plotted as function of energy. A.

539.172.13

7366. Angular distribution of protons and tritons from reactions $Be^9(d, p)Be^{10}$ and $Be^9(d, t)Be^8$. M. K. JURIĆ. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 7–13 (*March*, 1955).

A thin Be target was bombarded with deuterons of the energy $E_d = 0{\cdot}6$, $0{\cdot}8$, $0{\cdot}9$, $1{\cdot}0$, $1{\cdot}1$, $1{\cdot}2$, $1{\cdot}3$ and $1{\cdot}45$ MeV, and the angular distribution of long proton and triton tracks from the reaction $Be^9(d, p)Be^{10}$ and $Be^9(d, t)Be^8$ examined. The coefficients of the Legendre polynomials were calculated for the angular distribution curves and plotted as a function of energy. A.

539.172.13

7367. Development of the angular distribution of the $O^{16}(d, p)O^{17*}$ protons in the neighbourhood of a deuteron capture resonance. A. BERTHELOT, R. COHEN, E. COTTON, H. FARAGGI, T. GRJEBINE, A. LEVEQUE, V. NAGGIAR, M. ROCLAWSKI-CONJEAUD AND D. SZTEINSZNAIDER. *J. Phys. Radium*, **16**, *No.* 4, 241–52 (*April*, 1955) In French.

The angular distribution in the forward direction has been studied by the photographic plate method, at seven energies between $1{\cdot}66$ and $2{\cdot}20$ MeV. The shape of the distribution is in good agreement with that predicted by stripping theory with $l = 0$. However, the cross-section at 7° goes through a maximum at the deuteron capture resonance, in qualitative disagreement with the simple assumptions of the Butler theory. J. M. CASSELS

539.172.13

7368. On the reaction $Ne^{20}(d, p)Ne^{21}$. S. GORODETZKY, T. MULLER AND M. PORT. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1704–7 (*April* 25, 1955) In French.

The relative cross-sections at 90° were observed for deuteron energies between $0{\cdot}73$ and $1{\cdot}16$ MeV. Four definite, and one probable, proton groups were seen; they correspond with the levels of Ne^{21}. A resonance in the excitation curve indicates a level in Na^{22} at about 12 MeV. J. M. CASSELS

539.172.13

7369. On the excited levels of Li^7 and Be^8 produced in the disintegration of Be^9 by low-energy deuterons. P. CÜER and J. J. JUNG. *J. Phys. Radium*, **16**, *No.* 5, 385–7 (*May*, 1955) In French.

The products of the reactions $Be^9(d, \alpha)Li^{7*} \rightarrow \alpha + t$(I) and $Be^9(d, t)Be^{8}(Be^{8*})$(II) for $E_d = 1{\cdot}25$ MeV were analysed magnetically and recorded using nuclear emulsions. For (I) the triton distribution indicates clearly a large contribution due to the $4{\cdot}6$ MeV level of Li^7, and probably a level at $\sim 6{\cdot}7$ MeV; no level at $5{\cdot}5$ MeV [Stoll, Abstr. 2186 (1955)] was detected. For (II) only the well-known level at $2{\cdot}8$ MeV was observed in the range 0–3 MeV. A. O. STANESBY

539.172.13

7370. Angular momentum coupling in deuteron reactions. T. AUERBACH AND J. B. FRENCH. *Phys. Rev.*, **98**, *No.* 5, 1276–80 (*June* 1, 1955).

Information about nuclear coupling schemes which can be derived from relative cross-sections in deuteron stripping and pickup reactions in light nuclei is considered. In a few cases, experimental results are applied to give a determination of the intermediate-coupling parameter. A.

539.172.13

7371. Search for the reaction $T(d, \gamma)He^5$. G. A. SAWYER AND L. C. BURKHARDT. *Phys. Rev.*, **98**, *No.* 5, 1305–7 (*June* 1, 1955).

An attempt was made to detect the reaction $T(d, \gamma)He^5$, using a Cockcroft–Walton accelerator. A tritium-zirconium target was bombarded with 160 keV deuterons. A NaI scintillation counter was used to search for 16 MeV γ-rays from the $T(d, \gamma)He^5$ reaction. No 16 MeV γ-rays were detected. It was concluded that the cross-section was less than $0{\cdot}5$ millibarn at 160 keV. A.

539.172.3

7372. Photoneutron cross sections in Mg^{24}, Mg^{25}, Zr^{90}, Zr^{91}. R. NATHANS AND P. F. YERGIN. *Phys. Rev.*, **98**, *No.* 5, 1296–9 (*June* 1, 1955).

The variation of $\sigma(\gamma, n)$ with E_γ from threshold to 24 MeV has been measured by detecting neutrons produced from betatron bremsstrahlung irradiation of separated isotope samples in oxide form. Despite the large threshold differences (9·3 MeV for the Mg isotopes and $5{\cdot}0$ MeV for the Zr isotopes) the peaks of the giant dipole resonances are very close for each pair of adjacent isotopes: Mg^{24}, $19{\cdot}5$ MeV; Mg^{25}, $20{\cdot}3$ MeV; Zr^{90}, $16{\cdot}4$ MeV; Zr^{91}, $16{\cdot}3$ MeV. The half-widths of the Zr resonances are unusually small, $4{\cdot}1$ and $5{\cdot}4$ MeV, compared to 8 MeV for nearby nuclei observed previously. This is apparently a "magic number" effect. A.

539.172.4

7373. Note on the $^6Li(n, d)^5He$ reaction. J. DABROWSKI AND J. SAWICKI. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 2, 91–4 (1955).

The differential cross-section is calculated with the assumption that the Li^6 nucleus consists of a deuteron moving in the field of an α-particle. The incoming neutron "knocks out" the deuteron and is itself captured. The n–α interaction is largely ignored, and "pick-up" is neglected because the deuteron is treated as an elementary particle. Nevertheless fair agreement with experiment is obtained. J. M. CASSELS

539.172.4

7374. Inelastic collision cross sections at 1·0-, 4·0-, and 4·5-MeV neutron energies. J. R. Beyster, R. L. Henkel, R. A. Nobles and J. M. Kister. *Phys. Rev.*, **98**, *No.* 5, 1216–24 (*June* 1, 1955).

Inelastic cross-sections have been obtained from measurements of sphere transmission for incident neutron energies of 1·0, 4·0, and 4·5 MeV. Cross-sections were measured for Al, Fe, Cu, Zn, Ag, Cd, Sn, Au, Pb, and Bi at the three neutron energies. In addition, the carbon inelastic cross-section was measured at 1·0 MeV, the Be, C, Ti, Ni, Zr, and W cross-sections were measured at 4·0 MeV, and the Ti, Ni, Zr, and W were measured at 4·5. The cross-sections were determined at about ten energy thresholds of the neutron detector to obtain information about the energy spectra of inelastic neutrons. The experimental techniques and the method of evaluating the measurements are discussed. The results of this investigation are compared with other determinations of inelastic cross-sections. A.

539.172.4

7375. Radiation width variations in the slow-neutron resonances of europium and indium. H. H. Landon and V. L. Sailor. *Phys. Rev.*, **98**, *No.* 5, 1267–71 (*June* 1, 1955).

The parameters of the lowest-energy resonances in europium and indium have been determined from total cross-section measurements using the Brookhaven crystal spectrometer. The data have been analysed for variations in the radiation-width parameter $\Gamma\gamma$ from resonance to resonance. The method of analysis used to take account of Doppler effect in the observed cross-section is discussed. The radiation width in the 0·327 eV resonance in Eu is 70 ± 10 mV, which is definitely smaller than that for the 0·461 eV and 1·056 eV resonances which are respectively 93 ± 3 mV and 94 ± 3 mV. The widths of the 1·456 eV and 3·85 eV resonances in In are 72 ± 2 mV and 81 ± 4 mV respectively. The remaining one-level parameters for each resonance are also presented. A.

539.172.4

7376. Angular distribution of fast neutrons scattered from lead. W. J. Rhein. *Phys. Rev.*, **98**, *No.* 5, 1300–1 (*June* 1, 1955).

The elastic differential cross-sections for the scattering of 1·0, 3·7, 5·0 and 15·0 MeV neutrons from lead have been measured, using a minimum of experimental variables in order to investigate the behaviour of these cross-sections as a function of neutron energy. The scatterers were ring-shaped, permitting a scattering range between 10° and 150°. The neutrons were counted with ZnS–plastic scintillators. It was necessary to subtract the effects of inelastically scattered neutrons from the experimental results in order to arrive at the elastic cross-sections. The results show the expected prominent variation in the width and height of the forward scattering peak and indicate that the number and direction of the secondary maxima of scattering are a prominent function of neutron energy. A.

539.172.4 : 539.152.1

7377. Nuclear cross sections for 1·4-BeV neutrons. T. Coor, D. A. Hill, W. F. Hornyak, L. W. Smith and G. Snow. *Phys. Rev.*, **98**, *No.* 5, 1369–86 (*June* 1, 1955).

Transmission measurements in good and poor geometry have been performed at the Brookhaven Cosmotron to measure the total and absorption cross-sections of several nuclei for neutrons in the BeV energy range. The neutrons are produced by bombarding a Be target with 2·2 BeV protons. The neutron detector requires the incident particle to pass an anticoincidence counter and produce in an aluminium radiator a charged particle that will traverse a four-fold scintillation telescope containing 6 in. of lead. Contribution of neutrons below 800 MeV are believed small. The angular distribution of neutrons from the target is sharply peaked forward with a half width of 6°. The integral angular distributions of diffraction-scattered neutrons from C, Cu, and Pb are measured by varying the detector geometry. The angular half-width of these distributions indicates a mean effective neutron energy of $1{\cdot}4 \pm 0{\cdot}2$ BeV. The total cross-sections σ_H and $\sigma_D - \sigma_H$ are measured by attenuation differences in good geometry of CH_2-C and D_2O-H_2O, with the result: $\sigma_H = 42{\cdot}4 \pm 1{\cdot}8$ mb, $\sigma_D - \sigma_H = 42{\cdot}2 \pm 1{\cdot}8$ mb. The cross-sections of eight elements from Be to U are measured in good and poor geometry, and the following values of the total and absorption cross-sections are deduced (in units of millibarns):

	Be	C	Al	Cu
σ_{total}	310	380	700	1 390
$\sigma_{absorption}$	190	200	410	670
	Sn	Pb	Bi	U
σ_{total}	2 200	3 210	3 280	3 640
$\sigma_{absorption}$	1 160	1 730	1 790	1 890

Experimental errors are about 3% in σ_{total} and 5% in $\sigma_{absorption}$. An interpretation of these cross-sections is given in terms of optical model parameters for two extreme nuclear density distributions: uniform (radius R) and Gaussian [$\rho = \rho_0 \exp -(r/a)^2$]. The absorption cross-section data are well fitted with $R = 1{\cdot}28\,A^{\frac{1}{3}}$ or $a = 0{\cdot}32 + 0{\cdot}62\,A^{\frac{1}{3}}$ in units of 10^{-13} cm. A nuclear density distribution intermediate between uniform and Gaussian will make the present results consistent with the recent electromagnetic radii. A.

539.172.4 : 539.152.1

7378. High-energy cross sections. I. The size of the nucleus. R. W. Williams. *Phys. Rev.*, **98**, *No.* 5, 1387–92 (*June* 1, 1955).

An analysis is made of the recently available measurements of the absorption (reaction) cross-sections for nuclei for 1·4 BeV neutrons (preceding abstract). The nature of the approximations involved in interpretating such data is discussed, and it is pointed out that these measurements are more directly related to the nuclear density distribution than are the lower-energy measurements. If it is assumed that the density drops off smoothly to zero at the edge of the nucleus, in accord with electron scattering results, it is found that the size of the nucleus determined from these nuclear experiments is in good agreement with the size determined from electromagnetic experiments. This fact indicates that the

spatial distribution of the protons is probably equal to that of the neutrons, and cannot be smaller by as much as 1×10^{-13} cm, even for heavy nuclei. A simple formula is given for the nuclear density distribution; the radius of the uniform (square-well) density distribution which yields the same $[r^2]_{Av}$ is $r_0 = 1{\cdot}19\,A^{\frac{1}{3}}\times10^{-13}$ cm; the corresponding square-well radius for nuclear interactions is larger, and depends on the type and energy of observation. Some results are presented of a method for treating the effect of the finite range of interaction of the neutrons.

A.

539.172.4 : 539.152.1

7379. High-energy cross sections. II. Nucleon–nucleon cross section at cosmic-ray energies. R. W. Williams. *Phys. Rev.*, **98**, *No.* 5, 1393–7 (*June* 1, 1955).

Cosmic-ray measurements are capable of yielding reliable results for the cross-section of a nucleus for proton or neutron collisions involving a not too small energy transfer. This cross-section should therefore be less than, or at most equal to, the true nonelastic cross-section (reaction cross-section). Results of recent cosmic-ray work are assembled and compared with the reaction cross-sections measured at 1·4 BeV with the Brookhaven Cosmotron; it is found that the cosmic-ray cross-sections are significantly larger, even for Pb. Assuming a nonuniform distribution of the density of nuclear matter, one can explain this surprising effect as the result of an increase in the elementary nucleon–nucleon cross-section with energy. It is shown that the elementary cross-section (the average of σ_{pp} and σ_{np}) must be $(120^{+30}_{-20})\times10^{-27}$ cm^2 in the neighbourhood of 30 BeV.

A.

539.172.4 : 539.172.13

7380. Coulomb effects in the ^{6}Li$(n,\alpha)^3$H and ^{6}Li$(p,\alpha)^3$He reactions. J. Sawicki. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 957–61 (*May*, 1955).

For Li^6 the "$\alpha + d$" model is used [see Abstr. 4073 (1955) where this problem was formulated in Born-approximation]. The incident neutron combines with the deuteron to form H^3. The n–d interaction is taken here to have zero range. The outgoing triton is described by a Coulomb wave-function, although Coulomb polarization of the internal function is neglected. Coulomb effects change the absolute cross-section, but not the angular distribution.

G. E. BROWN

539.172.4 : 539.18

7381. Production of charged pions in N–P collisions. G. B. Yodh. *Phys. Rev.*, **98**, *No.* 5, 1330–47 (*June* 1, 1955).

The differential cross-section and energy spectra for the production of $\pi\pm$ mesons by the 400 MeV neutron beam of the Chicago synchrocyclotron on liquid hydrogen has been measured at 90° and 65° in the laboratory, using photographic emulsions as detectors. At 65° (corresponding to 90° in the centre-of-mass system), roughly equal numbers of positive and negative pions were observed, while at 90° the ratio of positive to negative pions was found to be 2·01 ±0·24. The laboratory integrated cross-secions $(d\sigma_{Av}/d\Omega)_{Av}$, in cm^2/sterad, are: for π^+ at 90° $(2{\cdot}296 \pm 0{\cdot}363)\times10^{-29}$, for $T > 14$ MeV; for π^- at 90°, $(1{\cdot}56 \pm 0{\cdot}357)\times10^{-29}$, for $T > 14$ MeV; for π^+ at 65°, $(1{\cdot}22 \pm 0{\cdot}30)\times10^{-29}$, for $T > 41$ MeV; and for π^- at 65°, $(1{\cdot}31 \pm 0{\cdot}63)\times10^{-29}$. These experimental cross-sections are the result of production due to neutrons of all energies above the threshold for pion production in the neutron beam. A phenomenological analysis is made for the reaction $N + P \rightarrow \pi\pm$ under the hypothesis of charge independence and the energy and angular distributions of the pions at a single neutron energy are deduced from the experimental cross-sections. The total cross-section for π^+ or π^- production, at neutron energy 409 MeV, is determined to be $\sigma(\pi^+) = \sigma(\pi^-) = 0{\cdot}16 \pm 0{\cdot}04$ millibarn, and the differential cross-section for the same neutron energy is calculated to be $(d\sigma/d\omega)^{\pm} = (1{\cdot}07 \pm 0{\cdot}39) \mp (1{\cdot}38 \pm 0{\cdot}78)\cos\theta + (0{\cdot}57 \pm 1{\cdot}14)\cos^2\theta \times 10^{-29}$ cm^2/sterad.

A.

539.172.4

7382. Model for asymmetric fission. R. D. Hill. *Phys. Rev.*, **98**, *No.* 5, 1272–6 (*June* 1, 1955).

On the basis of shell effects, asymmetric fission is attributed to symmetrical division except for a non-fissionable core. Distributions of fission-fragment yields, v. fragment charges and masses, are obtained from simple statistical considerations of the division.

A.

539.172.4

7383. U^{235} thermal neutron fission yields at masses 90 and 91. G. W. Reed. *Phys. Rev.*, **98**, *No.* 5, 1327–9 (*June* 1, 1955).

Thermal neutron fission yields in U^{235} have been determined for Sr^{90} and for Y^{91}. The fission yield at Sr^{90} is 4·02% based on a half-life of 20 years. The yield for Y^{91}, 5·35%, agrees within experimental error with that previously reported for Sr^{91}. The apparent low yield at mass 90 is discussed.

A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

7384. A statistical analysis of jets. T. F. Hoang *Nuovo Cimento Suppl.*, **12**, *No.* 2, 342–3 (1954). *See Abstr.* 9631 (1954).

539.18

7385. Observations on heavy mesons and hyperons. *Nature* [*London*] **175**, 971–3 (*June* 4, 1955).

Brief description of recent high-altitude work, and summary of results.

539.18

7386. A new example of a χ meson in photographic emulsions. V. Fouché and J. Trembley. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 16, 1638–40 (*April* 18, 1955) In French.

The secondary particle, produced by the decay of the heavy meson, has a range of 8·3 cm and is identified as a π-meson ($M = 265 \pm 14\,m_e$) with an energy of 105·2 MeV. The decay scheme $\chi^{\pm} \rightarrow \pi^{\pm} + \pi^0$ leads to a mass value $M_\chi = (952 \pm 13) \pm 6$.

H. ELLIOT

539.18

7387. On the mean lives of heavy unstable particles. N. DALLAPORTA. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 962–5 (*May*, 1955).

These are estimated within the framework of the Gell-Mann–Pais suggestions [Abstr. 6489 (1955)] by the exclusive use of known interaction constants. No need for a new type of interaction is apparent.

W. J. SWIATECKI

539.18

7388. Remarks on the multiple electromagnetic interactions of μ mesons. D. KESSLER AND R. MAZE. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 966–7 (*May*, 1955) In French.

539.18

7389. Diffusion cloud-chamber study of very slow mesons. I. Internal pair formation. C. P. SARGENT, R. CORNELIUS, M. RINEHART, L. M. LEDERMAN AND K. ROGERS. *Phys. Rev.*, **98**, *No.* 5, 1349–54 (*June* 1, 1955).

A beam of negative π and μ mesons was moderated to very low energies and allowed to enter a hydrogen-filled 20 atm continuously sensitive cloud chamber. The various phenomena were observed and classified. A detailed study was made of the internal pair formation of mesonic γ-rays produced in the pion–hydrogen reactions. The conversion coefficient for the reaction $\pi^0 \rightarrow \gamma + e^+ + e^-$ was found to be $0{\cdot}0053 \pm 0{\cdot}0009$; for the reaction $\pi^- + p \rightarrow n + e^+ + e^-$ the coefficient is $0{\cdot}0062 \pm 0{\cdot}0013$. Distributions in angle and energy were obtained from thirty-five of the forty-seven observed cases. A.

539.18

7390. On the theory of multiple production of particles at higher energies. S. Z. BELEN'KIĬ. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 111–13 (1955) In Russian.

The relative numbers and energies (E) of nucleons, antinucleons and pions (N_π) in Fermi's theory of multiple production [as worked out in Abstr. 9275 (1951), 5771 (1954) and *Uspekhi fiz. Nauk*, **52**, 185 (1954)] are calculated as functions of the initial numbers of nucleons (N_0) involved in the collision ($N_0 \geqslant 2$) and the temperature T at which the statistical system disintegrates into separate particles. If $T = 1{\cdot}2\, m_\pi c^2$, then for $N_0/N_\pi = 0{\cdot}15$, E (nucleons + antinucleons)$/E_\pi = 0{\cdot}42$ and for $N_0/N_\pi = 1$, E(n. + a.)$/E_\pi = 2{\cdot}3$. The results are generalized to the case when Λ-mesons of mass $2\,200\, m_e$ are also created. W. J. SWIATECKI

539.18

7391. The determination of meson multiplicity at about 20 BeV. C. B. A. MCCUSKER. *Z. Naturforsch.*, **10a**, *No.* 3, 238–42 (1955).

A discussion of the difficulties involved in such determinations. It is concluded that to distinguish between multiple and plural production it is necessary to use a thin H target and to reduce the bias against registering events with few charged particles. It seems possible at the moment to reconcile all existing experimental evidence if it is assumed that at 20 BeV multiple production of mesons does not predominate.

W. J. SWIATECKI

539.18

7392. Remarks on excited states of short life-time and meson production. B. D'ESPAGNAT AND J. PRENTKI. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 14, 1514–16 (*April* 4, 1955) In French.

Peaslee's method of introducing real excited intermediate nucleon states when discussing meson production is examined in terms of the life-times involved. It is shown that for certain cases, such as π-production in π-nucleon collisions, the method can lead to large errors. G. FIELD

539.18

7393. The formation of π^0 mesons by neutrons. B. M. PONTEKORVO AND G. I. SELIVANOV. *Dokl. Akad. Nauk SSSR*, **102**, *No.* 2, 253–6 (1955) In Russian.

This paper is based on work done in 1951–2 at the Institute of Nuclear Problems. Neutrons of about 400 MeV were collimated and directed at specimens of seven elements ranging from beryllium to lead, and γ-quanta produced by the decay of π^0 mesons were recorded by a counter arrangement. The total cross-section for π^0 meson formation by neutrons at carbon was found to be $3 \pm 1{\cdot}5$ millibarn. The total cross-section for other elements, expressed as a ratio to that for carbon, varies from $0{\cdot}8 \pm 0{\cdot}1$ (Be) to $5{\cdot}0 \pm 1{\cdot}7$ (Pb). It is shown that this cross-section is proportional, within the limits of error, to $ZA^{-1/3}$. This is in agreement with the theoretical relation, derived on the hypothesis that the π^0 meson absorption mean free path in nuclear matter is less than the diameter of the nucleus, supposed spherical. A further paper is to give the corresponding results for π^0 meson formation by neutrons at hydrogen and deuterium. J. B. SYKES

539.18

7394. Λ^0–θ^0 production in π^-–P collisions at 1 BeV. W. D. WALKER. *Phys. Rev.*, **98**, *No.* 5, 1407–10 (*June* 1, 1955).

Two examples of Λ^0–θ^0 production have been found in the collision of $1{\cdot}0$ BeV π^- mesons with protons. Data on these two cases are given. The two cases are qualitatively similar, yet there are quantitative differences in terms of the angles of production of the θ^0 and Λ^0 particles. One case is internally consistent with the production of a Λ^0 and θ^0 directly. The other case, in which the Λ^0 and θ^0 particles seem slightly non-coplanar with the incoming π^- meson, is not internally consistent with the direct production of a Λ^0 and θ^0. It is likely that either the θ° or the Λ^0 or both θ^0 and Λ^0 are the products of decay of heavier parents. It is also possible that a light particle (γ or ν) may be produced simultaneously with the θ^0 and Λ^0. If one supposes that the Λ^0 is the product of decay of a heavier parent then the Q of such a parent, were it to decay into a proton and π^- meson, is calculated to be 117 ± 30 MeV. This Q value is close to that of the charged hyperons. A short-lived neutral hyperon of this mass has been predicted by Gell-Mann. A.

539.18

7395. The production of mesons and excited states having a short lifetime. B. D'ESPAGNAT AND J. PRENTKI. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1223–37 (*June*, 1955) In French.

Concerns the models for meson production which

make use of an intermediary excited nucleon X having a short lifetime, e.g. $\pi + \mathfrak{N} \rightarrow \pi + X \rightarrow \pi + \pi + \mathfrak{N}$. The legitimacy of drawing from such a hypothesis, together with charge independence, simple clear cut conclusions as to the relative numbers of mesons created with various charges is discussed. It is shown that, contrary to what might be expected at first sight, these ratios depend, in a complicated way, on the line width (lifetime) of the excited state. Only in the case of a line width small compared to excitation energy do they reach the values given by the more customary and elementary approach. Isotopic spin conservation is assumed. For simplicity calculations have been made using scalar meson theory without recoil; reactions (1) and (2) are treated as an example. The method consists in calculating the matrix elements of the T matrix for the whole process, i.e. without supposing implicitly that X be real. The intermediary state hypothesis is introduced and the important contributions of damping are taken into account by solving the appropriate Heitler equations. The general result is given by a formula which shows that the limiting value of σ_{0+}/σ_{++} can hardly be a good approximation unless the line width Γ of the excited state is less than about a tenth of its excitation energy Δ. It is concluded that when X is identified with the $I = J = 3/2$; $\Delta = 150$ MeV, $\Gamma \approx 80$ MeV excited state of the nucleon, the elementary approach for the calculation of such ratios should not be considered as reliable. A.

539.18

7396. Coulomb interference in the pion–proton scattering at 120 MeV. L. Ferretti, E. Manaresi, G. Puppi, A. Ranzi and G. Quareni. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1238–50 (*June*, 1955).

A complete angular distribution for the positive pion–proton elastic scattering at 120 MeV is presented. The angular distribution deals with angles in the c.m. between 15° and 180° and is based on 545 events. The analysis of the differential cross-section for angles >30° gives, as phase shifts for the partial waves, $p_{\frac{3}{2}}$, $p_{\frac{1}{2}}$ $\alpha_3 = \pm 12°\cdot 2$, $\alpha_{33} = \pm 31°\cdot 4$, $\alpha_{31} = \pm 1°\cdot 5$. The choice of the sign of the phase shifts is based on the frequency of the events in the angular interval 15°–30°. The present experiment gives evidence for the upper system of signs: the relative probability of the two systems of signs being 18. A.

539.18

7397. Form factors for incoherent scattering of high energy charged particles by nuclei. V. Benzi. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1261–3 (*June*, 1955).

The incoherent form factor given by Gatto [Abstr. 3887 (1954)] is calculated for light nuclei assuming a shell model structure and an oscillator potential.

G. E. BROWN

539.18 : 537.534.74

The use of overlapping intervals in multiple scattering measurements. *See Abstr.* 7138

539.181

7398. The large interaction cross-section for the collision between neutral atoms. W. Jawtusch, G. Schuster and R. Jaeckel. *Z. Phys.*, **141**, *No.* 1–2, 146–59 (1955) In German.

The apparatus and experimental technique are described. The measurements are an extension of those described earlier [Abstr. 5110 (1953), Abstr. 9636 (1954) and Abstr. 2216 (1955)]. J. HUGHES

539.181

7399. A universal detector for molecular beams. G. Fricke. *Z. Phys.*, **141**, *No.* 1–2, 166–70 (1955) In German.

The molecular beam is mechanically modulated and ionized by electron bombardment. The resulting ions are analysed by a mass spectrometer and detected by an electron multiplier. A molecular beam density of 1×10^5 molecules/cm^3 can be detected in the presence of a residual gas pressure of approx. 3×10^{-9} molecules/cm^3. J. HUGHES

539.181

7400. A conductivity detector for the detection of molecular beams. G. Fricke and H. Friedburg. *Z. Phys.*, **141**, *No.* 1–2, 171–4 (1955) In German.

The detector is based on the strong influence of foreign atoms on the conductivity of semiconductors. The suitability of a thin Cu_2O layer for detecting an iodine molecular beam was shown experimentally.

J. HUGHES

539.185

7401. The mean free path of slow neutrons in nuclear matter. C. B. O. Mohr. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 4, 340–1 (*April*, 1955).

The variation with A of (thermal neutron scattering length)/(radius) around $A = 150$ was calculated for a 40 MeV deep square well and a well with rounded edges (like that of Woods and Saxon, 1954). Ratios of imaginary to real potential of 0, 0·04 and 0·1 were tried; experimental points suggest a value 0·04–0·1.

W. J. SWIATECKI

539.185 : 537.311.33

Fast-neutron bombardment of *n*-type Ge. *See Abstr.* 7050

539.185

7402. Spontaneous-fission neutrons of californium-252 and curium-244. D. A. Hicks, J. Ise, Jr and R. V. Pyle. Letter in *Phys. Rev.*, **98**, *No.* 5, 1521–3 (*June* 1, 1955).

Further measurements of the multiplicities of prompt neutrons from the spontaneous fission of Cf^{252} ($\nu = 4\cdot 06 \pm 0\cdot 14$) and Cm^{244} ($3\cdot 01 \pm 0\cdot 11$) have been made in a large Cd-loaded scintillator. See also Abstr. 4104 (1955). A. O. STANESBY

539.185 : 538.221

7403. Multiple scattering of slow neutrons by flat specimens and magnetic scattering by zinc ferrite. B. N. Brockhouse, L. M. Corliss and J. M. Hastings. *Phys. Rev.*, **98**, *No.* 6, 1721–7 (*June* 15, 1955).

Measurements of scattering from Be, Pb, Bi and Th under conditions where multiple scattering predominated were compared with predictions based on the work of Chandrasekhar and of Vineyard. Good agreement was obtained. A table of values of the expected multiple scattering by flat specimens is given. These results were used to correct measurements of diffuse scattering by zinc ferrite at room temperature

and higher to obtain the differential magnetic cross-section of the magnetic ions. The cross-section shows interesting features which are discussed. At liquid-nitrogen temperatures a small-angle scattering effect was found. This is interpreted as arising from short-range ferromagnetic ordering of the iron ions. A.

539.185.07

7404. Performance of a fast neutron collimator. J. T. SAMPLE, G. C. NEILSON AND J. B. WARREN. Note in *Canad. J. Phys.*, **33**, *No.* 6, 350–1 (*June*, 1955)

The performance is described of a neutron collimator consisting of 7, 1½ in. thick, 6 in. × 6 in. paraffin slabs interposed with 4 ¼ in. thick steel plates. When DD neutrons were passed through ½ in. × 1 in. holes in the paraffin, the collimator "half width" was approximately 1½°. D. R. CHICK

539.185.08

7405. Fluorescent uranium glass. O. Ž. KOVAČEVIĆ AND V. N. KOSTIĆ. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 49–52 (*March*, 1955).

An investigation of the possibility of fission detection and thermal neutron flux measurements by the use of a Na–K–uranium–silicate glass (molar proportion: 2 SiO_2 : ½ Na_2O : ½ K_2O) with 15 w. % of uranylnitratehexahydrate. The thermal neutron flux was determined from the number of fission pulses, that of U^{235} atoms on a square centimetre of uranium glass and the fission cross-section of U^{235}. A.

539.185.7

7406. Neutron absorption in a semi-infinite region. J. S. DWORK AND H. HURWITZ, JR. Letter in *J. appl. Phys.*, **26**, *No.* 5, 642–3 (*May*, 1955).

The Wiener–Hopf method has been used to calculate the neutron absorption in the half-space $z<0$ when there is a uniformly distributed neutron source in the half-space $z>0$. The ratio of scattering cross-section to total cross-section is assumed to differ in the two half-spaces. J. M. CASSELS

539.185.9 : 548.5

Effect of reactor irradiation on the white-to-grey tin transformation. *See Abstr.* 7500

STRUCTURE OF SOLIDS 539.2

539.213

7407. On the amorphous state of the binary system of nickel–sulfur. M. SAWADA, K. TSUTSUMI, T. SHIRAIWA AND M. OBASHI. *J. Phys. Soc. Japan*, **10**, *No.* 6, 459–63 (*June*, 1955).

Simultaneously electro-deposited Ni–S specimens containing 0, 9, 13, 17 and 25 wt % sulphur were prepared and their crystalline forms studied by X-ray diffraction patterns. The diffraction patterns of Ni–S containing 13 and 17% S show a uniform fog, and 7% S shows a halo, and 0 and 25% S are the same as those of Ni and Ni_3S_2 respectively. All amorphous samples crystallized after they had been heated to 180°C, and their diffraction patterns show the crystalline states of the two-phase region of Ni and Ni_3S_2. The electrical resistances of these samples were measured in a vacuum furnace and in an oil bath. The resistances of these samples containing 9, 13 and 17% S gradually decrease as the temperature increases and suddenly drop at 180°C, then follow the usual behaviour of the common metals for both increasing and decreasing temperatures. In the case of 0% S it does not differ from that of the pure nickel. It is concluded that the amorphous state has a structure of a certain regularity, and that 180°C is the transition point of amorphous Ni–S to the perfect crystal state. A.

539.213.1

7408. The limits of glass formation. A. WINTER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1878–80 (*May* 9, 1955) In French.

Continuation of previous work [Abstr. 3155 (1955)]. It is found empirically that glass formation in inorganic melts is governed by the number of *p*-electrons per atom. R. O. DAVIES

539.213.28

7409. On the mechanism of aging in aluminium–silver alloys. III. Variation of the Young's modulus. K. TANAKA, H. ABE AND K. HIRANO. *J. Phys. Soc. Japan*, **10**, *No.* 6, 454–8 (*June*, 1955).

For Pt II, see Abstr. 3156 (1955). Variations of Young's modulus and internal friction during the ageing of a supersaturated solid solution of 20 wt. % silver in aluminium has been examined on polycrystalline specimens by the high-frequency method at about 13 kc/s; both isothermal ageing curves and heating curves have been obtained. It has been found that the formation of the Guinier–Preston zone results in decrease of the Young's modulus, whereas precipitation of the new phase results in increase of it. The results have been discussed from the point of view that the formation of the Guinier–Preston zone is not a preliminary stage of the precipitation process. The effect of ageing on internal friction measured at room temperature has been found negligible. Further, temperature variations of Young's modulus and internal friction have been examined on a pure aluminium specimen in comparison with those of the present alloy. A.

539.216 : 541.64

7410. Molecular orientation and self-stress in extruded polystyrol parts. K. HECKEL. *Z. angew. Phys.*, **7**, *No.* 6, 291–4 (1955) In German.

At the end of the extrusion process the polystyrol rigidifies so quickly that macro-Brownian movement is insufficient to reduce the thread molecules again to random order. In practice this molecular orientation is significant for changes in mechanical rigidity of the extruded parts. Since the photoelastic constant of polystyrol is small double refraction due to pressure can be ignored. J. JACOBS

539.217

7411. Kinetics of precipitation in aluminium–silver alloys. G. BORELIUS. *Defects in crystalline solids* [*Bristol*] 169–74. See Abstr. 5707 (1955).

A detailed analysis of the kinetics of precipitation in the alloy Al 10 weight % Ag is given. Experimental information used concerns time of growth of the

coherent γ' phase as a function of temperature and of cold work, rate of evolution of heat measured microcalorimetrically, resistance changes and hardness changes. Several distinct transformations can be followed in various temperature ranges. ε and ε' are pre-precipitation inhomogeneous solutions forming above and below 100°C respectively. γ' is formed above 200°C and transforms to incoherent γ. Below 200°C "Kaltaushärtung" results from formation of η phase. A semiquantitative equilibrium diagram is given. W. M. LOMER

539.217

7412. Diffusion of radioactive calcium in $Ca_3Si_2O_7$. R. LINDNER AND A. S. OBERMAYER. Letter in *J. chem. Phys.*, **23**, *No.* 5, 988–9 (*May*, 1955).

Preliminary results in the determination of the diffusion coeff., D, of Ca^{45} in $Ca_3Si_2O_7$ show that D increases a hundredfold at about 1 260°C. The self-diffusion coeffs. calculated from measurement of ionic conductivity do not agree with the coeffs. measured with the radioactive tracer. W. GOOD

539.217

7413. Ring diffusion as the mechanism of self-diffusion in germanium. S. MAYBURG. Letter in *Phys. Rev.*, **98**, *No.* 4, 1134–5 (*May* 15, 1955).

Quenching experiments show that the concentration of Frenkel defects is given by $n/N = 6{\cdot}7\, e^{-46{,}100/RT}$. It is impossible to reconcile this with the measured self-diffusion coefficient $D = 7{\cdot}8\, e^{-68{,}500/RT}$ cm²/sec on the assumption that interstitials are responsible unless D_0 for interstitial diffusion is surprisingly high. It is also calculated that it is not possible to retain interstitials on quenching if they are as mobile as this requires; it appears that ring diffusion may explain this anomaly. W. M. LOMER

539.217 : 537.311.33

7414. Diffusion of antimony, arsenic and indium in solid germanium. W. BÖSENBERG. *Z. Naturforsch.*, **10a**, *No.* 4, 285–91 (1955) In German.

p–n junctions were formed in germanium crystals by addition of Sb, As, or In to the melt during growth. The breadth of the transition region can be related to the capacity of the junction, and this was used to follow the change in breadth on annealing, which allows diffusion of the impurity. Results for D_0 and activation energy for Sb, As, In were respectively 1·2, 2·1, and 20 cm²/sec, and 2·3, 2·4 and 3·0 eV. The same values may be derived from the diffusion into Ge of evaporated layers of impurity.

W. M. LOMER

539.217 : 539.16.08 : 541.123.59

7415. On diffusion of radioactive ions in ion exchangers. S. SUGAI AND J. FURUICHI. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1181 (*June*, 1955).

The self-diffusion of Ca ions in Dowex 50 was measured by bringing the calcium chloride saturated resin into contact with aqueous calcium chloride solutions containing Ca^{45}. The results indicate that in solutions more concentrated than ~0·5 molar the rate-determining factor in the mechanism of the ion exchange is the bulk diffusion of Ca ions in the resin. W. GOOD

539.217 : 539.38 : 548.5

7416. Distortion effects produced by crystals in porous materials. Z. GYULAI. *Acta phys. Hungar.* **4**, *No.* 3, 189–96 (1955) In German.

In porous bodies such as porcelain, which have been soaked in salt solution and subsequently exposed to the air for a long time, crystal growth in the pores produces flaking of the surface, and woolly growths on the surface. It is believed that these phenomena depend on the mobility of salt ions in the adsorbed layers of water. W. M. LOMER

539.217.1 : 539.23 : 537.523.3

7417. Method of detection of pores in varnish layers and other insulating films. C. H. HERTZ. *Z. angew. Phys.*, **7**, *No.* 4, 183–7 (1955) In German.

A rapid method for counting pores having diameters down to 4–6μ or even smaller. A negative voltage of about 5 kV is applied to a fine wire fixed 5 mm above a metal plate covered with the varnish or film. The corona produces a glow discharge in the pores, which can then be counted with the help of a microscope. Refinements permit the detection of pores in thin films (1–2μ thick) such as aluminium oxide. Applicable to varnishes, cellulose paints and packaging films. I. D. L. BALL

539.219.2

7418. Pressure crack-figures on diamond faces. I. The octahedral face. V. R. HOWES AND S. TOLANSKY. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 287–93 (*June* 21, 1955).

By pressure with a diamond ball, oriented hexagonal-shaped ring cracks (pressure marks) are produced on the octahedral face of a diamond. Typical ring cracks have a side length of the order of $\frac{1}{25}$ mm and appear at stresses of the order of $1{\cdot}4 \times 10^{11}$ dyn. cm^{-2}. The development of these figures is studied, using regularly increasing loads. After primary crack formation, further increase of loading leads to the appearance of concentric multiple cracks. The permanent surface distortions accompanying these percussion marks are studied with multiple-beam interferometry. It is established that the region within the hexagonal figure is effectively at the zero undisturbed level. At the perimeter there is a discontinuity, the surface rising in a typical instance by some 300 Å. There is then a gradual smooth fall off to zero level. It is considered that the interferograms offer strong evidence for the existence of plastic flow. The volume of displaced material surrounding a typical primary crack is some 10^{-9} cm³. The mechanism of the hexagonal crack formation is discussed in terms of directions of easy cleavage, and accompanying cracking effects within the body of the crystal are discussed. A.

539.219.2

7419. Pressure crack-figures on diamond faces. II. The dodecahedral and cubic faces. V. R. HOWES AND S. TOLANSKY. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 294–301 (*June* 21, 1955).

The study of pressure figures on diamond is extended to the cubic and dodecahedral faces. The formation of cracks on a sawn but unpolished dodecahedral (two-point) face is first studied. The

loads required for the initiation of cracks, using a diamond ball, were between 7 and 24 kg. Two different types of cubic face were available, one on a natural cubic boart stone, the other a polished approximation to a cube face secured by truncating an octahedral stone. The loads required to initiate cracks were of the order 20 to 30 kg. All the cracks observed were specifically oriented in accordance with crystallographic expectations of easy cleavage directions. The cracks were accompanied by permanent surface distortions which were studied by multiple-beam interference methods. The permanent distortions broadly resemble those found in Pt I for octahedral faces. There is one important difference in that for both the cube faces studied, the surface level within the perimeter of the ring crack is appreciably depressed, being some 800 Å below the outer undisturbed level. This is considered to offer further evidence for the existence of plastic flow in diamond at room temperature. For the polished cube face studied observations could also be made on the accompanying internal cracking effects within the body of the crystal. A.

539.234 : 539.27

7420. On the structure of evaporated thin films of metals. S. Ogawa, D. Watanabe and F. E. Fujita. *J. Phys. Soc. Japan*, **10**, *No.* 6, 429–36 (*June*, 1955).

It has been confirmed by many electron diffraction studies that the single-crystal-like films of silver, gold, copper, and nickel, which are formed on heated cleavage surfaces of rocksalt by evaporation *in vacuo*, have repeated twinning structures. However, the thickness, the area, and the repeat frequency of the twinned layer have not yet been studied. These points are studied by means of the electron microscope. Parallel, linear stripes are observed in electron micrographs. These stripes are attributed to the twinned lattice, the thickness of which is of the order of 100 Å. Parallel, linear stripes are not observed for aluminium. This agrees with the fact that no twinning occurs in this metal. A.

539.26

7421. The W–K_α interference pattern from liquid antimony. H. Hendus and H. Müller. Note in *Z. Naturforsch.*, **10a**, *No.* 3, 254–5 (1955) In German.

The high vapour pressure of liquid Sb requires a sealed-off specimen, and the high absorption limits the specimen thickness to 0·2 mm. Allowance was made for α_1–α_2 doublet separation, and the main maxima in the pattern correspond to planes separated by 2·98, 1·47 and 1·01 kX, which correspond with only some of those observed for amorphous Sb. W. M. Lomer

539.26 : 536.421.1

7422. Molar volume and structure of solid and molten cesium halides. J. W. Johnson, P. A. Agron and M. A. Bredig. *J. Amer. Chem. Soc.*, **77**, *No.* 10, 2734–7 (*May* 20, 1955).

X-ray diffraction patterns of solid caesium iodide and bromide taken at temperatures up to the melting points gave no evidence of any transition from a simple cubic to a face-centred cubic structure similar to the transition which occurs in caesium chloride at 469°. Discussion of the molar volumes of the solid and liquid salts at the melting points leads to the conclusion that the structural change from 8- to 6-fold co-ordination, which in the chloride takes place in solid phase at 469°, occurs in the bromide and iodide at their melting points as part of the fusion process. The % volume expansions on melting for the bromide and iodide, 26·8 and 28·5, are essentially equal to the sum of the expansions in the chloride at its transition and melting points, 17·1 + 10·0 = 27·1%. A.

539.26 : 539.4.016.2

7423. X-ray measurements of particle size and strain distribution in cold worked silver. F. R. L. Schoening and J. N. van Niekerk. *J. appl. Phys.*, **26**, *No.* 6, 726–8 (*June*, 1955).

X-ray diffraction profiles from filed solid silver specimens were measured with a Geiger counter spectrometer using crystal-reflected Cu $K\alpha$ radiation. It is shown that for values of $n>7$, the assumption of a Gauss strain distribution fits the observed Fourier coefficients far better than a Cauchy distribution. The results obtained from solid specimens are consistent with those previously measured for silver filings. The influence of background errors is discussed. A.

539.27

7424. On the temperature rise of the object in an electron beam (in the problem of the hardening process in thin films). A. Winkelmann. *Z. angew. Phys.*, **7**, *No.* 6, 296–7 (1955) In German.

Electron-diffraction investigation of the hardening of aluminium–silver in the form of thin layers [Abstr. 3905 (1954), 3191 (1955)] showed more rapid hardening than was found by X-ray diffraction from the bulk material. A possible cause was the rise of temperature of the specimen in the electron beam in the diffraction apparatus. A theoretical investigation is now made of the temperature rise to be expected: (*a*) in the thin metal layer alone, in radiation equilibrium and neglecting thermal conductivity; (*b*) in the supporting metal mesh, taking both radiation and conductivity into account. For the very low electron loading ($1{\cdot}45\times10^{-4}$ A.cm^{-2}) and large electron spot (3 mm dia.) employed, it is calculated that the maximum temperature to be expected in a layer 600 Å thick is 31°C and in the supporting grid 27°C. The heating effect of the electron beam therefore cannot be the cause of the discrepancy between X-ray and electron diffraction results. V. E. Cosslett

539.27

7425. Use of replicas in the examination of fibres by reflection electron microscopy. D. E. Bradley. *Research* Correspondence, **8**, *No.* 3, S12–S13 (*March*, 1955).

A replica method for examining structures which are easily damaged by the electron beam in the reflection electron microscope is described. The initial replica impression is made in plastic. This is then coated with silver by vacuum evaporation, and backed with thick electrodeposited copper. The metal layer is then stripped off and examined by the normal reflection technique. Faithful reproduction of the original and resistance to damage by the beam are demonstrated by replica photographs of fibres.

A.E.I. RESEARCH LABORATORY

539.27

7426. Intensity variations of electron diffraction patterns from metal films of various thicknesses. S. KUWABARA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 5, 416 (*May*, 1955).

Discusses the conditions of potential and thickness under which the diffracted intensity can be interpreted on the dynamic and kinematic theories respectively.

J. THEWLIS

539.27

7427. A replica technique for "reflexion" electron microscopy. D. E. BRADLEY. *Brit. J. appl. Phys.*, **6**, *No.* 6, 191–5 (*June*, 1955).

Specimens of low thermal conductivity which are damaged by heat cannot easily be examined in the reflection electron microscope. A replica technique is described which allows the surface topography of such specimens to be reproduced in a silver surface. This can then be observed at the full intensity of the electron beam by the reflection technique. The application of this technique to the examination of fibres, crystals and biological specimens is considered. The results obtained show that the use of replicas considerably widens the scope of reflection electron microscopy, and simplifies the examination of specimens in some already established fields. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

7428. The complete elasticity law for some metals according to Poynting's observations. M. REINER. *Appl. sci. Res. A*, **5**, *No.* 4, 281–95 (1955).

The general stress-strain equation of an isotropic elastic material formulated by Reiner is solved exactly in closed form for the case of torsion of a circular cylinder. This is examined in the light of Poynting's observations on metal wires which revealed that a simple torsional torque produced lengthening of the wires and cubical dilatations. It is shown that Reiner's equation is confirmed by Poynting's observations with four constant moduli, namely the classical bulk and shear modulus and in addition the modulus of cross-elasticity and the modulus of dilatancy. Numerical values of the latter are calculated for steel and hard copper. A.

539.31

7429. Internal stresses and the incompatibility tensor in elasticity theory. E. KRÖNER. *Z. angew. Phys.*, **7**, *No.* 5, 249–57 (1955) In German.

Analogies between the elastic theory of externally stressed and self-stressing media on one hand and the theory of electrostatics and of stationary current distributions on the other are set up. Internal stresses arise from deviations from the compatibility relations and a new tensor operator is introduced to handle this. A simple relation between the stress functions and the incompatibility is derived. Dislocation lines are analogous to current loops, and the stress functions to the vector potential. The problem of stresses round pre-precipitation zones in Al–Cu alloys is solved in this formalism. W. M. LOMER

539.31

7430. Researches on the solid state at high temperatures using ultrasonics. P. G. BORDONI. *J. Phys. Radium*, **16**, *No.* 4, 285–91 (*April*, 1955) In French.

Measurements of the velocity of elastic waves as a function of temperature follow the predictions of statistical mechanics up to about $0{\cdot}8\ T_m$. Above this temperature, relaxation effects cause a rapid change in the elastic moduli, but these tend to a finite limit as the melting point is reached. These relaxation processes represent an energy dissipation and are probably connected with creep processes. W. M. LOMER

539.31 : 536.631

Vibration spectra and specific heats of cubic metals. Application to silver. *See Abstr.* 6996

539.31 : 536.7

7431. Experimental examination of the statistical theory of rubber elasticity. Low extension studies. F. P. BALDWIN, J. E. IVORY AND R. L. ANTHONY. *J. appl. Phys.*, **26**, *No.* 6, 750–7 (*June*, 1955).

An experimental study was made of the behaviour of two rubbers, Butyl (GR–I–18) and Paracril-35, in the low extension region (0 to 15%), at temperatures ranging from −40°c to +60°c. The results have been compared with the Guth–James theory of rubber elasticity. In general, good agreement with theory was observed. Two effects predicted by the theory have been confirmed, namely, the nonlinear dependence of stress upon temperature at constant extended length, and the shift of the thermoelastic inversion extension to higher values with increasing temperature. Small deviations, which increased with increasing extension and with decreasing temperature, were observed. A.

539.32 : 539.219

7432. Elastic properties of lead zirconate. M. MARUTAKE AND T. IKEDA. *J. Phys. Soc. Japan*, **10**, *No.* 6, 424–8 (*June*, 1955).

Elastic properties of $PbZrO_3$ and its solid solutions with $PbTiO_3$, $BaZrO_3$ and $SrZrO_3$ were studied by measuring resonant frequencies of bars by the composite-bar method. In the antiferroelectric range, they show elastic behaviour similar to barium titanate; and to explain these anomalies, interactions between strains and anti-parallel oriented dipoles—micro-piezoelectric effects—were introduced in a phenomenological theory. It was also pointed out that the elastic compliance coefficient for constant polarization (s^P) of $BaTiO_3$ changes discontinuously at the Curie point and that the Devonshire's theory is insufficient. In addition, it was revealed from elastic and dielectric measurements that $(Pb_{0.85}-Sr_{0.15})ZrO_3$ has another new phase, the nature of which, however, could not be determined. A.

539.374

7433. Viscoelasticity of poly methacrylates. F. BUECHE. *J. appl. Phys.*, **26**, *No.* 6, 738–50 (*June*, 1955).

Variation of the viscous and elastic properties is studied as a function of temperature in the range $60 < T < 160$°c, as a function of molecular weight in the range $5\times10^5 < M < 5\times10^6$, and as a function of plasticizer concentration over the range 0–100%. Capillary viscometers were used in the low-viscosity

systems and tensile creep and recovery measurements under very small loads were used to study the less fluid systems. Principal effort was confined to polymethylmethacrylate but enough work was done using the butyl and decyl esters to show that the whole series of these polymers fits into a relatively simple picture. Consequently, given a certain minimum amount of data, it is now possible to predict the viscoelastic behaviour of these polymers in the range of variables given above. The theory of viscoelasticity previously given has been extended so as to take account of the effects of chain entanglements and distributions in molecular weight. Moderately good agreement is found between theory and experiment. A.

539.374 : 537.311.32

Effect of plastic deformation on the electrical conductivity of silver bromide. *See Abstr.* 7025

539.374 : 538.245

7434. Magnetic investigations on internal strains in plastically stretched carbon steel. L. REIMER. *Z. angew. Phys.*, **7**, *No.* 6, 282–4 (1955) In German.

It is shown, by a comparison of the high-field regions of the magnetization curves of plastically extended and strain-free annealed steel, that there is a general compressional strain in the ferrite as a result of the local distortions around cementite inclusions. Magnetic measurements above the Curie point of the cementite confirm this conclusion. A. E. DE BARR

539.374 : 538.245

Influence of plastic deformation on the Barkhausen effect. *See Abstr.* 7196

539.389.3

7435. The relaxation of stress in fused silica. I. Experimental. J. O. ISARD AND R. W. DOUGLAS. *J. Soc. Glass Technol.*, **39**, 61 T–82 T (*April*, 1955).

It is shown that the relaxation of stress in fused silica can be expressed by the equation $(S/S_0) = f(t)$. This equation is a mathematical expression of the experimental fact that if the material is uniform in composition and previous heat treatment, and after a given time interval the stress at a point has fallen to half its value at that point at the beginning of that time-interval, the stress at any other point will also have halved its value in the same time-interval. For a Maxwellian body $(S/S_0) = \exp.(-Gt/\eta)$, where G = rigidity modulus, η = coefficient of viscosity. It is shown that vitreous silica does not behave as a Maxwellian body in this respect for two reasons: (1) if the material is not in configurational equilibrium, η changes with time; (2) even when in configurational equilibrium, the exponential decay of stress is not found, and this is attributed to the effect of "delayed elasticity" or "viscoelasticity." A.

539.389.3

7436. The relaxation of stress in fused silica. II. Theoretical. J. O. ISARD AND R. W. DOUGLAS. *J. Soc. Glass Technol.*, **39**, 83 T–98 T (*April*, 1955).

The experimental relation $(S/S_0) = f(t)$ for the release of stress in glass is studied theoretically. It is shown that this relation would be expected, both in Maxwellian body and in a body exhibiting delayed elasticity. The shape of the stress-relaxation curve is influenced by: (*a*) the viscosity varying with time; and (*b*) by delayed elasticity. The delayed elastic effect found in the experiments recorded in the first of these two papers is unlikely to be accounted for by the effect of pressure on the atomic configuration. It is also shown that the empirical equations which Adams and Williamson (1920), and Bailey and Sharp (1933) used to express the results of their observations on the annealing of glass can be derived as special cases of the general theory. A.

539.389.3

7437. The stress–time relation in glass during annealing. H. N. RITLAND. *J. Soc. Glass Technol.*, **39**, 99 T–112 T (*April*, 1955).

A discussion is presented of the release of internal stress in glass at constant temperature, based on a simple viscous-flow mechanism with the viscosity increasing linearly with time as suggested by Douglas and Isard (preceding abstracts). Data published by Lillie (1936) are shown to be in excellent agreement with this interpretation. Some implications of a linearly increasing viscosity are discussed in connection with the corresponding change of fictive temperature as determined by the increase of the density of a borosilicate crown glass with time. A.

539.389.3

7438. Dislocation relaxations at low temperatures and the determination of the limiting shearing stress of a metal. W. P. MASON. Letter in *Phys. Rev.*, **98**, *No.* 4, 1136–8 (*May* 15, 1955).

It is shown that the low activation-energy process responsible for anelastic effects at low temperatures can be accounted for on a simple model involving displacement of dislocation loops by a single atomic distance. The frequency-independent higher temperature rise in damping is attributed to the occasional unpinning of the ends of the loop, by freeing it from impurity atoms. W. M. LOMER

539.389.3

7439. Short-time stress relaxation behavior of plastics. M. T. WATSON, W. D. KENNEDY AND G. M. ARMSTRONG. *J. appl. Phys.*, **26**, *No.* 6, 701–6 (*June*, 1955).

An apparatus for measuring stress relaxation of plastics at constant strain in the time range of 0·01 to 2·5 sec after load application is described. Experimental results obtained indicate that rigid plastics at room temperature may be classified as either brittle or ductile. Brittle plastics sustain only low strains without fracture at the testing speed of the apparatus and undergo little relaxation of stress in this time range; ductile plastics sustain higher strains and undergo considerable relaxation of stress. The factors affecting relaxation behaviour are briefly discussed. Increasing the strain, temperature, or plasticizer content generally increases the relaxation rate. Many of the results yield a linear plot of stress *v.* logarithmic time, as has been reported in the literature for various materials tested at longer times. By application of one form of the Eyring absolute rate theory, an average free energy of activation for the relaxation process can be calculated. The value thus calculated

for polymethyl methacrylate is in the range reported in the literature for other polymers. An empirical measure of "toughness" can be based on these results. For many plastics this measurement is in accord with service performance. A.

539.4.016.2

7440. Energy relations in cold working an alloy at 78°K and at room temperature. J. S. L. Leach, E. G. Loewen and M. B. Bever. *J. appl. Phys.*, **26**, *No.* 6, 728–32 (*June*, 1955).

The energy relations associated with the plastic deformation by cold working of a 75% gold–25% silver alloy at two temperatures were investigated. The samples were produced by drilling under controlled conditions, which is a suitable method of deformation. The energy stored in the chips was measured by tin solution calorimetry and the total energy expended in the deformation was determined from dynamometer measurements. The results for cutting with a drill having the most suitable geometry were as follows. The energy stored at room temperature was 0·50 cal/g and the corresponding value for 78°K was 1·48 cal/g. The values of the total energy of deformation were 53·5 cal/g at room temperature and 109 cal/g at 78°K. The true stress-true strain curve at room temperature was normal for a non-ferrous metal and the curve for 78°K showed the behaviour expected at low temperature from a face-centred cubic metal. A.

539.434

7441. On the effect of heavy-particle irradiation on the plasticity of metal crystals. E. Schmid and K. Lintner. *S.B. Österr. Akad. Wiss. IIa*, **163**, *No.* 1–4, 109–21 (1954) In German.

The effect of α-particle bombardment on the creep curves of Zn single crystals was investigated using Po sources of between 10 and 20 mC strength. The tests were carried out by measuring flow rates at constant stress for one minute, with 3 minute pauses, alternate pauses and flow curves being under α-bombardment. At all stresses the creep rate was reduced by α-rays as though a hardening was introduced. A radon–beryllium neutron source of about 1 000 mg Ra–γ equivalent gave small increases of creep rate.

W. M. LOMER

539.434 : 539.67

7442. Internal friction of white tin single crystal. T. Komata. Letter in *Nature* [*London*] **175**, 948 (*May* 28, 1955).

Measurements of Young's modulus and of internal friction in a cylindrical single crystal of tin were carried out at various temperatures and strain amplitudes. A break in the curves versus strain amplitude is seen at stresses corresponding to the change from α to β creep. The internal friction is exponentially dependent on $1/T$ except above the recrystallization temperature. W. M. LOMER

539.434 : 541.183

7443. Physico-chemical phenomena during straining of metals. V. I. Likhtman. *Uspekhi fiz. Nauk*, **54**, *No.* 4, 587–618 (1954) In Russian.

The paper seeks to bring together the approaches of solid-state physics and surface-reaction chemistry to the influence of the surrounding medium on the properties of metals undergoing strain. The effect of adsorption is discussed at some length; also creep in single crystals, and the influence of solutions of surface-active agents. The differing views on the role of oxide layers are given. A short section deals with the electrocapillarity effect, lastly the influence of the medium upon the mechanical properties of polycrystalline metals is summarized. Well-balanced list of 32 references. C. R. S. MANDERS

539.501

7444. Rheological behaviour of continuously sheared polyethylene. W. F. O. Pollett. *Brit. J. appl. Phys.*, **6**, *No.* 6, 199–206 (*June*, 1955).

A commercial grade of polyethylene was tested between its melting point and 190°C at constant shear rates from 0·1 to 9·8 sec^{-1}. A disk-and-cone rheometer was used, and an improved technique introduced to provide a complete picture of the pressure distribution in the flowing melt by measuring each normal and tangential stress component individually. Changes of great complexity occurred with increasing shear, and varied with temperature and rate of shear, but simple relations could be established between the stress components and the measured strain recovery. These relations were not much affected by the imposed conditions and were in reasonable agreement with Weissenberg's theory when account was taken of an appropriate correction to his calculated recoverable strain. Moreover, the normal stress component in the axial direction was shown to be equal to that in the radial direction, in quantitative agreement with Weissenberg's theory. Changes occurred in the material during shearing, and increased with the applied shear and with the stress, but were reversible and vanished on resting. The observed behaviour is attributed to successive structural changes in the polymer, and an attempt is made to define equivalent structural states produced at different rates of shear.

A.

539.501

7445. A versatile absolute rotating cylinder plastometer. P. Mason and L. M. Smith. *J. sci. Instrum.*, **32**, *No.* 7, 275–9 (*July*, 1955).

The construction and method of use of a rotating cylinder plastometer with a wide annulus are described. Absolute shearing stress-strain-time data can be obtained for liquids with viscosities in the range 10^4 to 10^{12} poises as well as for pastes of a wide range of consistency. Continuous loading can be used to produce shearing stresses in the material ranging from about 50 to 5×10^6 dyn/cm^2: transient loading with variable duration and frequency can also be applied from about 10^4 dyn/cm^2 upwards. A stress range of 20 : 1 can be covered in one test. Examples of application to the study of rubber-bitumen systems and asphalts are given. A.

539.61

7446. Problems of adhesion. B. V. Deryagin. *Research*, **8**, *No.* 2, 70–4 (*Feb.*, 1955).

A condensed translation of a Russian paper [*Vestnik Akad. Nauk SSSR*, **7**, 30 (1954)] describing the work done in that country and a review of the current views on the subject. The commonly

accepted idea of the relation of surface tension to adhesion behaviour is stated to be not quite right. One observation proving this, being the variation of specific adhesion with velocity of separation which could not be explained on the surface tension theory. The type and number of chemical bonds per unit area is however important, an example being the role of sulphur in the vulcanizing process. The electrical double layer at the boundary is thought to be exceedingly important, and very extensive experimental work has been carried out on electron emission when an adhesive film is removed quickly from a metal or dielectric surface so that separation occurs at the boundary. The results explain the variation of adhesion with gas pressure on the basis of discharge in gases. When separation takes place over the whole contact area simultaneously the important mechanism becomes a molecular one, separation depending upon stress at the interface. Factors especially in need of further research are indicated. T. C. TOYE

539.62 : 621.315.5.066.6

7447. Apparatus for studying friction and sliding electrical contacts. D. G. FLOM. *Rev. sci. Instrum.*, **26**, *No.* 1, 1–4 (*Jan.*, 1955).

The apparatus is designed for tests, if required, *in vacuo* and with precise temperature control. It consists of a stainless steel bell-jar with plexiglass windows. Inside is a rotating cylinder of one of the materials under test, the cylinder being driven, through a magnetic coupling, from a variable-speed $\frac{1}{3}$ h.p. motor outside. The other material under test is attached to a rider and bears against the cylinder under a normal force controlled by a push rod. The rider can be lifted from the cylinder by winding up a nylon thread, again through a magnetic coupling. The friction is measured by means of strain gauges attached to the rider holder and indicating the deflectional force. Recorded charts of μ against cylinder rotation are shown for brass–copper and steel–steel contacts.

H. G. M. SPRATT

539.621

7448. Effects of temperature and high-speed sliding on the friction of "Teflon" on "Teflon." D. G. FLOM AND N. T. PORILE. Letter in *Nature* [*London*] **175**, 682 (*April* 16, 1955).

Experimental work using a Teflon rider on a rotating Teflon cylinder reveals the facts that (1) the coefficient of friction at low speeds is very low only if the surfaces have not previously been subjected to high-speed sliding, and (2) with rising temperature there is a marked increase in friction at ~20°C. The first point indicates the important effects of surface preparation and conditioning. The second feature is undoubtedly related to the phase transition which takes place at 20°C. The first change is irreversible: the second reversible. H. G. M. SPRATT

539.87

7449. Variation of the elastic constants of quartz as a function of pressure up to 1 000 atmospheres. C. SUSSE. Letter in *J. Phys. Radium*, **16**, *No.* 4, 348–9 (*April*, 1955) In French.

By measuring the variation in the resonant frequency of Y, AT and BT cut resonators it is found that

$$\frac{1}{c_{66}}\frac{dc_{66}}{dp} = -6{\cdot}8\times10^{-6}\,\mathrm{cm^2.kg^{-1}},$$

$$\frac{1}{c_{44}}\frac{dc_{44}}{dp} = 4{\cdot}9\times10^{-6}\,\mathrm{cm^2.kg^{-1}},$$

$$\frac{1}{c_{14}}\frac{dc_{14}}{dp} = -9{\cdot}0\times10^{-6}\,\mathrm{cm^2.kg^{-1}}.$$

W. BARDSLEY

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.124 : 530.145

7450. Quantum mechanics in forecasting chemical reactivity. R. COUCEIRO DA COSTA. *Rev. Fac. Ciênc. Univ. Lisboa B*, **3**, *No.* 2, 197–226 (1954) In Portuguese.

A general summary of quantum-mechanical methods used for calculating electronic energies of polyatomic (homoatomic and heteroatomic) organic molecules. The 28 references quoted date mostly from 1947–54. The polar chemical reactivity of the π bonds is calculated for several "alternating" (with even-number cycles) and "non-alternating" hydrocarbons, and the effect of position in substituted benzenes is discussed. Dewar's theory of the π complexes, and the relationship between electronic energies and carcinogenicity of compounds are referred to. F. LACHMAN

541.126

7451. The significance of reactions of low activation energies to the mechanism of combustion. F. J. WEINBERG. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 331–42 (*June* 21, 1955).

The effect of the magnitude of activation energy on reaction rates has been examined. The conclusions suggest that a valid approximation to combustion mechanisms should be obtainable from a consideration of a single rate-controlling chain-branching and a single rate-controlling chain-breaking step. This concept has been applied in turn to homogeneous auto-ignition, ignition lags, limits of inflammability, flame propagation and burning velocities, resulting in a simple co-ordinating scheme. The formulae derived imply methods of identification of the rate-controlling processes from measurable flame properties. A.

541.126 : 536.46

7452. Evaluation of activation energies from burning velocities. N. W. LUFT. *Research* Correspondence, **8**, *No.* 3, S 13–S 14 (*March*, 1955).

Various theories of flame-propagation conclude that burning velocity v_b and activation energy E are related by $\log_e v_b = -E/2RT + a' \log_e T + c'$ where T is the abs. temp. and a' and c' are temp.-independent

factors, the precise value and meaning of which differ between different theories. It is suggested that the application of this relation to the evaluation of activation energies has been neglected owing to an exaggerated fear of the errors introduced by uncertainty of a' and c'; it is shown that in practice these are no greater than arise in applying the Semenov, Todes and Frank–Kamenetzky relation to estimate E from observed explosion-limits. Good agreement is found between activation energies calculated from the above relation and those from ignition-limits and kinetic experiments, e.g. in the cases of H_2, hydrocarbons and NH_3-excess O_2 mixtures. A. SCHOFIELD

541.126 : 551.594.221

7453. Chemical and electric explosions. D. M. HILLEBRAND. *Tekn. T.*, **85**, *No.* 23, 541–6 (*June* 7, 1955) In Swedish.

Whereas gunpowder burns without explosion at a rate of 0·01–0·13 m/sec, it explodes with a speed of 8 000 m/sec. The explosion is propagated as a compression wave. In lightning, the channel expands radially at supersonic speed dependent on the rate of variation of the current. With max. current 100 kA and rate of variation 20 kA/μsec, max. energy density in the channel would be 50 Wsec/cm^2 and the energy in 2 km channel 40 kWh. In a closed room, the pressure increases at explosions on account of temperature rise and, at high temperatures, dissociation. For gas mixtures the pressure increase is of the order of 9–17 atm, for solid explosives 250 000 atm is common. In lightning channels, temperatures of 30 000°c occur. The explosion phenomena are discussed and a report is given on explosion in a test structure, and on some lightning observations. J. A. WILCKEN

541.126.2

7454. The ignition mechanism in the Diesel engine. II. K. TERAO. *J. Phys. Soc. Japan*, **10**, *No.* 4, 304–12 (*April*, 1955) In German.

Continuing the previous study [Abstr. 4145 (1955)], many experimental results under various different conditions were obtained; the ignition mechanism proposed in the previous paper is discussed. A.

541.127

7455. The conception of the velocity of reaction. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41**, *No.* 3, 316–28 (1955) In French.

Theoretical. The problem is considered in terms of the masses involved in, and the affinities of, the chemical equations. The author distinguishes between the fundamental equations (I), based on stoichiometry, and the derived equations obtained by combinations of I. S. J. GREGG

541.127

7456. Tritium isotope effect in the isomerization of cyclopropane. R. E. WESTON, JR. Letter in *J. chem. Phys.*, **23**, *No.* 5, 988 (*May*, 1955).

The variation in the kinetic isotope effect as a function of pressure is investigated in order to test Lindemann's theory of unimolecular reactions. As the activation energy would be obtained from collisions, the reaction rate at high pressure would be determined by the decomposition rate of the activated molecule, at low pressure by the transfer of energy by collision. The isomerization of tritium-labelled cyclopropane to propylene was investigated. No isotope effect was observed at low pressure: this supports Lindemann's theory. The results at high pressure confirm the calculations of Slater, who found that the critical co-ordinate in the molecule is the CH distance rather than the CC distance. A. J. TAYLOR

541.127

7457. Trapped atoms and radicals in rigid solvents. I. NORMAN AND G. PORTER. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 399–414 (*June* 21, 1955).

A number of very reactive radicals and atoms prepared by photolysis in rigid hydrocarbon glasses at the temperature of liquid nitrogen have been detected by their absorption spectra. Thus ethyl iodide dissociates to iodine atoms which only recombine to give I_2 when the glass is softened. Similarly CS_2 and ClO_2 give CS and ClO which can be detected spectroscopically in the frozen glass. Toluene and other benzyl derivatives yield the benzyl radical, and the spectra of a number of similar unstable aromatic radicals have been recorded for the first time. Most of these radicals have lifetimes of less than 1 msec at comparable concentrations in the gas phase or in ordinary solutions, but have been observed for many hours in the rigid glass. The method should be of general applicability for the study of the primary products of photochemical or radiation chemical processes. A.

541.128 : 542.941

7458. Hydrogenation through metal septa. V. C. EWING AND A. R. UBBELOHDE. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 301–11 (*June* 21, 1955).

A method is described for studying hydrogenation reactions on metal surfaces. With an iron catalyst hydrogen atoms pass at a steady rate to the active surface, through an iron septum, the other face of which is made a cathode in a strong solution of sodium hydroxide. At current densities (I) ranging from 0·2 to 2·5 A/cm^2 and at temperatures ranging from 90 to 180°c the rate of emergence, N, of molecular hydrogen from the active surface into vacuum, in moles/cm^2. sec, can be represented by $N = KI^n \exp(-E/RT)$. K is not sensitive to temperature in the range investigated, $n \sim 0{\cdot}18$ and $E \sim 7{\cdot}9$ kcal/mole. Plots of N against I give evidence of a limiting rate of permeation at high current densities. Various gases have been brought into contact with the active surface of the iron. Molecular nitrogen neither reacted with the hydrogen permeating through the iron, nor did it block this permeation. More complex behaviour was observed with molecular oxygen. Over a range of conditions there was no combination between oxygen and hydrogen, but a substantial fraction of the iron surface was blocked, presumably by chemisorption of oxygen, leaving only part available for permeation of the hydrogen. At higher temperatures, especially at the lower densities, there was appreciable hydrogenation of the oxygen. A.

ELECTROCHEMISTRY 541.13

541.13 : 532.77

Electrons in solutions. *See Abstr.* 6794

541.13 : 537.71

7459. Critical notes on the units of electrical charge also electrochemically important. H. GÖHR AND E. LANGE. *Z. Elektrochem.*, **59**, *No.* 3, 147–52 (1955) In German.

In view of the numerical and dimensional discrepancy, viz. that 1 e.m.u./1 e.s.u. $= 3 \times 10^{10}$ cm.sec^{-1} on the one hand and 1 e.s.u. $\equiv$ 1 cm$^{\frac{3}{2}}$.g$^{\frac{1}{2}}$.sec^{-1} and 1 e.m.u. $\equiv$ 1 cm$^{\frac{1}{2}}$.g$^{\frac{1}{2}}$ giving 1 e.m.u./1 e.s.u. $=$ 1 sec.cm^{-1} on the other, the relation between the electrostatic and electromagnetic units of charge is discussed.

W. GOOD

541.133

7460. Measurement of surface conductivity. F. VAN RUTTEN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1887–9 (*May* 9, 1955) In French.

Aqueous solutions of HCl and KCl in very thin cells of both glass and quartz have been studied using an a.c. bridge method. The conductivities were found to be independent of the a.c. voltage, cell dimensions and the concentration of the solutions, but were affected by the material of the cell. A. E. KAY

541.135

7461. Preparation of extremely thin metallic threads. H. BITTEL. *VDI Z.*, **97**, *No.* 15–16, 486–8 (*May* 15, 1955) In German.

Details of a process, similar to that for the electrolytic polishing of metallic surfaces, are given for the preparation of very thin metallic threads or wires from materials of high tensile strength, e.g. copper-threads of $\sim 2\mu$ diameter and less. There are 7 diagrams and 7 references. H. H. HODGSON

541.135 : 539.155.2

7462. The isotope effect in the electrolytic migration of potassium ions in molten potassium nitrate. A. LUNDÉN, C. REUTERSWÄRD AND N. SJÖBERG. *Z. Naturforsch.*, **10a**, *No.* 4, 279–81 (1955) In German.

In the electrolysis of molten KNO_3 it was found that at the anode K^{41} is enriched compared with K^{39}. The relative difference in the electrolytic migration velocity of the two isotopes was found to be 0·0018. The mass effect, μ, was accordingly 0·036 which is not in agreement with the halogenide rule [Abstr. 1216 (1953)]. W. GOOD

541.135 : 539.155.2

7463. Isotopic enrichment in chlorine by electrolytic transport in molten lead chloride. A. KLEMM AND A. LUNDÉN. *Z. Naturforsch.*, **10a**, *No.* 4, 282–4 (1955) In German.

A current density of 5 A/cm^2 produced an enrichment of Cl^{35} by a separation factor of 2. It was established that the migration velocities of the two isotopes differ by 0·29 $\pm$ 0·02% and accordingly that the mass effect, μ, $= -0{\cdot}052 \pm 0{\cdot}003$.

W. GOOD

541.135.5

7464. Conditions of the formation and stability of layers at the electrodes in dielectrics. YA. N. PERSHITS. *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 181–90 (1955) In Russian.

The phenomena associated with formation and disruption of layers at the electrodes may be interpreted as follows: Admixtures present, or diffusing into, the dielectric, take the form of colloidal particles, and partly dissociate. The concentration of the ions depends on the temperature. At high temperatures the ions migrate to the electrode where they are neutralized. When current flows and the temperature falls, the concentration of the admixtures near the electrode may exceed the equilibrium concentration corresponding to this temperature, when coagulation occurs which increases the stability and resistance of the layer at the electrode. This also explains the reduction of the conductivity due to the admixture when the temperature falls. At changes of direction of the field the free ions leave the anode, so upsetting the equilibrium in the layer and causing additional ionization which may result in the complete disappearance of the anode layer. Simultaneously with the destruction of a more stable layer at one electrode a less stable layer is formed at the other electrode. The movement of the ions emitted by the anode layer takes the form of a cloud in which the concentration of the admixture ions is higher than in the remaining volume of the dielectric. If the field direction is again reversed, there is a new fixation of the ions at the boundary and the layer at the electrode is reconstituted. The observed variations of the coefficient of unipolarity may be interpreted as follows: A temperature rise increases the number of admixture ions which may contribute to electrode layer formation and/or the electric field driving the ions to the electrode increases the number of ions becoming fixed in the electrode layer. B. F. KRAUS

541.135.5

7465. An apparatus for the recording of impedances in electrochemical investigations. J. SCHÖN, W. MEHL AND H. GERISCHER. *Z. Elektrochem.*, **59**, *No.* 3, 144–6 (1955) In German.

A heterodyne method is described for the measurement of real and imaginary components of an impedance by means of phase-sensitive rectifiers. An application to the time variation of the capacity of the double layer of silver electrodes the surface of which were freshly produced by the reduction of AgCl coatings. W. GOOD

541.135.5 : 534.39 : 669.3 : 621.357.7

7466. The effect of ultrasonic waves on the electrodeposition of copper. W. R. WOLFE, H. CHESSIN, E. YEAGER AND F. HOVORKA. *J. Electrochem. Soc.*, **101**, *No.* 12, 590–6 (*Dec.*, 1954).

The effects were determined at frequencies of 200 and 1 000 kc/s with acid-sulphate plating baths of various concentrations. Polarization measurements indicate that ultrasonic waves produce a marked decrease in polarization, while X-ray diffraction studies indicate that ultrasonic waves increase the tendency for preferred orientation. These effects are correlated with disruption of concentration gradients at the electrode surface by ultrasonic waves. Schlieren photographs of the gradients support these conclusions. Microagitation associated with moderately intense ultrasonic waves seems considerably more effective than ordinary mechanical stirring in breaking up concentration gradients at an electrode. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

7467. Conductivity induced in polystyrene by X-rays. J. F. Fowler and F. T. Farmer. Letter in *Nature* [*London*] **174**, 800–1 (*Oct.* 23, 1954).

The induced conductivity is less than that in polythene or P.T.F.E. but the recovery time is longer: 30 minutes to 10% and 12 hours to 1%. The induced current $\propto$ (dose rate)$^{0\cdot6}$, and its variation with temperature shows the activation energy to be 1·2 eV with no irradiation and 0·44 eV under X-rays.

F. T. FARMER

541.15

7468. Action of γ-rays on polymers in the solid state. I. Reticulation of polyethylene. A. Chapiro. *J. Chim. phys.*, **52**, *No.* 3, 246–58 (*March*, 1955) In French.

Small specimens of polyethylene are irradiated with γ-rays (with and without oxygen) at various intensities while submitted to a constant load. Curves of extension against temperature are drawn, and the temperature at which the specimen flows or ruptures is determined. In presence of air a dose of 2·5 Mr is needed to make the polyethylene "infusible" when the radiation dosage rate is 400 r/min: at dosage rates less than 100 r/min, an oxidative degradation of the polymer occurs. The phenomena are interpreted on the basis of the formation of intermolecular bridges, of peroxidic structure, which decompose at 150–170°. 1 Mr of radiation *in vacuo* or in nitrogen renders polyethylene infusible irrespective of dosage rate. The following *G*-values for bridge formation are derived: In air, 0·75 bridges per 100 eV; *in vacuo*, 1·9 per 100 eV. The number of primary radicals per 100 eV, $G_R = 5\cdot1$. The paper contains a concise review of earlier work and an extensive bibliography.

C. B. ALLSOPP

541.15

7469. The interaction of β-particles with organic liquids in the presence of vinyl monomers. W. H. Seitzer and A. V. Tobolsky. *J. Amer. Chem. Soc.*, **77**, *No.* 10, 2687–92 (*May* 20, 1955).

Solutions of common organic liquids with vinyl monomers (either styrene or methyl methacrylate) have been exposed to a point source of β-particles, and the resulting rates of polymerization were measured for several monomer concentrations. An expression was derived which relates rate of chain initiation to the measured rate of polymerization in terms of the average absorption coefficient for the β-particles. The number of radical chain starters produced in the various organic liquids per 100 eV of energy absorbed was thereby calculated. A.

541.15

7470. Indirect and direct action of heavy particle radiation on acetic acid in aqueous solution. W. M. Garrison, W. Bennett, S. Cole, H.R. Haymond and B. M. Weeks. *J. Amer. Chem. Soc.*, **77**, *No.* 10, 2720–30 (*May* 20, 1955).

Chemical reactions induced by heavy-particle irradiation of acetic acid–water mixtures in the concentration range 0·0625 to 16 M have been studied. The principal products formed in dilute, oxygen-free acetic acid solutions at radiation doses below 5×10^{20} eV/ml are hydrogen, hydrogen peroxide and succinic acid. Carbon dioxide, methane, ethane and carbon monoxide are also produced. The radiation yields of all products increase with acetic acid concentration in the range 0·0625 to 1·0 M. With increasing acetic acid concentration above 1·0 M a continuous decrease in *G* values for hydrogen, hydrogen peroxide and succinic acid is observed. Values for the latter two products decrease essentially to zero in 16 M acetic acid. Radiation yields of carbon dioxide, methane, ethane and carbon monoxide, however, increase continuously with acetic acid concentration. With the exception of ethane, *G* values for these products show a linear dependency on acetic acid concentration. Mechanisms are proposed for both the indirect and direct action of radiation on the acetic acid molecule.

A.

541.15

7471. Geometrical corrections to the Bragg–Gray relation applied to absolute chemical dosimetry. P. J. Dyne. *Canad. J. Chem.*, **33**, *No.* 6, 1109–15 (*June*, 1955).

The γ-ray irradiation conditions for the valid application of the Bragg–Gray relation, which relates the energy deposition in a solid to the ionization in an air-filled cavity, are examined with particular reference to some published experiments on the yield of the radiation-induced oxidation of ferrous sulphate. It is pointed out that experiments in which divergent radiation is used will give a higher oxidation yield than the relation indicates. A quantitative treatment is advanced which accounts for the discrepancies between certain experimental results. A.

541.15

7472. Action of X-rays on dilute solutions of Uranine S. F. Patti. *J. Chim. phys.*, **52**, *No.* 1, 38–40 (*Jan.*, 1955) In French.

The dye was irradiated dry and in alcoholic and in aqueous solution. The loss of absorption in the blue light of a Wratten No. 47 filter and the loss of fluorescence were taken as the measure of the radiation effect. The detailed study was carried out with X-rays from a Mo tube filtered with 0·05 mm of Al at a distance of 10 cm, and dose rates of 7000 r/min (assumed mean wavelength 0·95 Å) on aqueous solutions containing 15γ/ml to 25γ/ml dye at pH 11·5. No changes were observed if the dye was exposed in the dry state or in alcoholic solution to X-ray doses of 150 000 r. Irradiations in water at pH 7 gave irreproducible results. In acid pH the radiation chemical yields were slightly higher than at pH 11·5. If the irradiation was carried out at pH 11·5 in the presence of O_2, both absorption and fluorescence decreased. Absorption measurements indicate that the decomposition is exponential with dose and increases with increasing concentration of dye from 15γ/ml to 25γ/ml. Exposure in the absence of O_2 left the absorption unchanged whereas the fluorescence decreased. No post-irradiation effects were observed. The yield was doubled when the wavelength of the radiation was changed from 0·95 Å to 1·5 Å. Radiation-produced H_2O_2 does not react with Uranine. The

author concludes that the radical HO_2 (in the presence of O_2) is responsible for the destruction of the chromophore group of the molecule. The H and OH radicals (in the absence of O_2) attack some other part of the molecules, destroying the fluorescence. M. EBERT

541.15

7473. Action of X-rays on dilute solutions of sodium eosinate. F. PATTI. *J. Chim. phys.*, **52**, *No.* 1, 77–9 (*Jan.*, 1955) In French.

Aqueous solutions at pH 6·4 containing 10·6γ/ml to 105γ/ml were exposed to X-rays of a mean wavelength 0·95 Å. Changes in the total absorption of the green light of a Wratten No. 61 filter in the fluorescence were taken as a measure of the effect. In the presence of O_2 the total optical density of solutions containing more than 20γ/ml increases for doses up to about 100 000 r, and decreases thereafter. In the absence of O_2 the yields were lowered considerably. At the maximum new bands of fluorescence appear, one in the green and one in the orange part of the spectrum. It was shown by paper electrophoresis that four new, unidentified molecules were formed by the radiation. Absorption spectra of irradiated solutions showed a shift of the minimum from 5 150 Å to 5 165 Å and a shift of the maximum from 5 850 Å to 6 000 Å. A post-irradiation effect was observed over a period of 600 hours after the irradiation of air was in contact with the solution. M. EBERT

541.15

7474. Effect of pile irradiation on sodium chlorate. L. J. SHARMAN AND K. J. MCCALLUM. Letter in *J. chem. Phys.*, **23**, *No.* 3, 597 (*March*, 1955).

Recrystallized and dried $NaClO_3$ was exposed to pile irradiation (neutron flux 4×10^{12} cm^2.sec) for 24 weeks, and analysed six months later to study the retention after the reaction $Cl^{35}(n,\gamma)\,Cl^{36}$. The molar ratios of $NaCl/NaClO_3/NaClO_4$ were found to be 0·33/1·00/0·04. They were compared with the ratios of Cl^{36} activity per mole, 21/1/1·1. The retention of Cl^{36} in ClO_3^- was 12·7%, which was bigger than those for the reactions $Cl^{37}\,(n,\gamma)\,Cl^{38}$ and $Cl^{35}(\gamma,n)\,Cl^{34}$. It is suggested that the high γ-ray dose in the pile oxidizes Cl^- to ClO_3^- and ClO_3^- to ClO_4^-. M. EBERT

541.15

7475. Radiation chemistry of aqueous benzene solutions. J. H. BAXENDAEL AND D. SMITHIES. Letter in *J. chem. Phys.*, **23**, *No.* 3, 604 (*March*, 1955).

Aqueous solutions of benzene were exposed to 190 kV X-rays at dose-rates ranging from 65 to 700 r/min, and the yields of phenol, diphenyl and peroxide were determined. In aerated neutral solutions the yield in molecules per 100 eV was $G(Ph) = 1·32$, $G(H_2O_2) = 2·14$ and $G(Ph_2) = 0$. No post-irradiation reactions were observed. In oxygen-free solutions, diphenyl was the major product, and its yield was independent of benzene concentration and dose-rate. The reaction scheme involved radiation-produced OH radicals. Photochemically produced OH radicals from Fe^{+++} or Cu^{++} in 0·1 N H_2SO_4 were used for the same reaction. From a quantitative comparison of the two reaction schemes, it was concluded that $G(OH) = 2·4$ and $G(H) = 2·7$ in 0·1 N H_2SO_4. M. EBERT

541.15 : 539.185

7476. Chemical effects of irradiation with heavy particles: the use of the ferrous sulphate–lithium sulphate system as a dosemeter for simultaneous thermal neutrons and ionizing radiations. I. DRAGANIC AND J. SUTTON. *J. Chim. phys.*, **52**, *No.* 4, 327–30 (*April*, 1955) In French.

The oxidation of an aqueous solution of ferrous ammonia sulphate to ferric, as a result of the nuclear reaction between thermal neutrons and lithium, in the form of lithium sulphate, is used as the basis of a thermal-neutron dosemeter. The oxidation is a linear function of the neutron flux and of the concentration of lithium. A.E.I. RESEARCH LABORATORY

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18 : 536.7

7477. Surface-active substances in solution. J. STAUFF. *Z. Elektrochem.*, **59**, *No.* 4, 249–59 (1955) In German.

A general discussion of the properties of solutions of micellar colloidal electrolytes is given. Thermodynamic calculations pertaining to paraffin chain salts in aqueous solution lead to the conclusion that the forces responsible for the surface activity and the formation of aggregates (micelles) have the same origin. W. GOOD

541.182/.183

7478. Analysis of the validity of the Gouy–Chapman theory of the electric double layer. G. H. BOLT. *J. Colloid Sci.*, **10**, *No.* 2, 206–18 (*April*, 1955).

Approximate expressions for the influence of dielectric saturation, polarization of ions, and ionic interactions on the structure of the electric double layer were derived and were incorporated in a generalized Poisson–Boltzmann differential equation for the electric double layer. The solution of this extended equation in terms of a correction function, to be applied to the standard Gouy–Chapman treatment of the double layer, showed that in the case of colloid suspension with a low concentration of co-ions (relative to the concentration of counter-ions) these corrections are small, provided the surface density of charge of the colloid does not exceed 2×10^{-7} meq/cm^2 (= 20 μcoulomb/cm^2). Especially the effects of dielectric saturation and polarization of the ions, being opposite in sign, balance each other rather closely. The effect of ionic interaction can be of some magnitude, the maximum effect probably occurring around the mentioned charge density of $2–3\times10^{-7}$ meq/cm^2. Above this value the short-range repulsion will start to exceed the effect of the Coulombic interaction, and eventually lead to a uniform concentration of ions over some distance from the plate. It is expected, therefore, that if the charge density of a colloid does not exceed 2×10^{-7} meq/cm^2, the Gouy–Chapman theory will give fairly reliable results, especially if the charge density of the colloid under consideration is constant. The conclusions drawn are in agreement with certain experimental observations. A.

541.182.2

7479. The electrical dispersion of liquids as aerosols. V. G. Drozin. *J. Colloid Sci.*, **10**, *No.* 2, 158–64 (*April*, 1955).

The dispersibility of a series of liquids at high electric potentials was investigated experimentally and theoretically. Large electrostatic pressure plays a predominant part in the process of dispersion and is a function of dielectric constant and radius of curvature of the liquid in the capillary. Nonpolar organic liquids having small dielectric constants could not be dispersed. Prediction of the dispersibility of a liquid can be made from knowledge of the value of its dielectric constant. A.

541.183 : 531.752

7480. An electromagnetic sorption balance. S. J. Gregg. *J. Chem. Soc.*, **1955**, 1438–9 (May).

A balance is described which permits one to follow the change in weight of a solid either *in vacuo* or when exposed to a gas at a temperature between −200° and 1 200°C. A change in weight of up to 4 g (±0·1 mg) on 25 g may be measured. A.

541.183 : 539.434

Physico-chemical phenomena during straining of metals. *See Abstr.* 7443

CHEMICAL ANALYSIS 543/545

545.37

7481. Voltammetry at constant current. *Analyt. Chem.*, **27**, *No.* 4(1), 478–91 (*April* 25, 1955).

Review of theoretical principles. P. Delahay and G. Mamantov (478–83).

Fundamentals of voltammetry at constant current are discussed and potentialities of the method as an analytical tool are examined. Concentrations are determined by measuring the transition time on potential-time curves. Relationships for transition-time and/or potential-time curves are discussed for reversible, irreversible, consecutive, stepwise, and kinetic processes. The influence of the capacity current in the selection of the density of electrolysis current is also considered.

Experimental evaluation. C. N. Reilley, G. W. Everett and R. H. Johns (483–91).

The feasibility of voltammetry at constant current (chronopotentiometry) as an analytical method is elucidated in the cathodic reduction and anodic oxidation of simple ions at platinum and mercury pool electrodes where transition times vary between 4 and 60 seconds. Interpretation of potential-time curves yields successful analytical results for solutions of single and mixed ions in concentrations of 5×10^{-5} to 1×10^{-2} M. Theoretical and experimental comparisons to other polarographic methods are discussed. Several supporting electrolytes are examined, and practical apparatus and technique are described. A.

545.8

7482. Magnetic oxygen measurement over small ranges. E. Grimm and H. Oster. *Siemens-Z.*, **29**, *No.* 5–6, 232–7 (*May*, 1955) In German.

A description with working details is given of the new Siemens and Halske (Oxymat) instrument for the quantitative measurement of oxygen in gaseous mixtures. This is based on the paramagnetic behaviour of oxygen which has a positive temperature-dependent volume susceptibility. The instrument is accurate for oxygen contents of 0–1% and 90–100%. 12 illustrations. H. H. Hodgson

545.8 : 539.152.2

7483. Technique for continuous intensity standardization in quantitative analysis by nuclear magnetic absorption. R. H. Elsken and T. M. Shaw. *Analyt. Chem.*, **27**, *No.* 2, 290–2 (*Feb.*, 1955).

A technique for nuclear magnetic absorption measurements provides for continuous comparison of the absorption signal with a reference standard. A Watkins–Pound calibrator circuit serves as a source of the reference signal. A servo-system is used to compare continuously the magnitudes of the reference and absorption signals. The method facilitates accurate determination of absorption line intensity. A.

545.82

7484. Double-beam method of spectral selection with flames. C. T. J. Alkemade and J. M. W. Milatz. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 7, 583–4 (*July*, 1955).

This describes an instrument in which a flame containing a metal salt gives selective absorption of a line. The flame is placed in one of the beams after the light has been chopped, so that the instrument becomes sensitive to the emission of this line from another test source. A colour filter is used, but no dispersive system. For full paper see Abstr. 5303 (1955). A. G. Gaydon

545.82 : 535.345

7485. Determination of Hg-202 and other mercury isotopes in samples of mercury vapor by mercury resonance radiation absorbiometry. K. R. Osborn and H. E. Gunning. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 552–5 (*July*, 1955).

A method is described for the determination of the percentage of Hg^{202} present in small samples of mercury. An electrodeless discharge tube containing Hg^{202} is used as a source of the Hg^{202} hyperfine component of the 2537 Å resonance line of mercury. By determining the absorbance of this component by mercury vapour, the quantity of the isotope present in the vapour can be determined. The analyses of samples of mercury containing various percentages of Hg^{202} agree with values obtained by mass spectrometric methods to within 2%. The method has the advantage over the mass spectrometer of requiring very much smaller samples. Furthermore, contamination from "hangup" of previous samples is avoided. Through the use of other isotopic sources it is shown that the method could be extended to the analysis of the remaining isotopes of mercury. A.

545.82 : 621.389

7486. Direct reading metal analysis. K. P. Rippon. *Commun. and Electronics* [*London*], **2**, *No.* 4, 56–9 (*April*, 1955).

This is effected by means of a spectroscopic tech-

nique which enables a complete analysis to be carried out in little more than 2 min with an accuracy of ~1%. The prepared pencil-like sample is placed in the arc stand and the resulting light analysed by a reflecting diffraction grating. There is a number of exit slits each with a separate photomultiplier cell. These cells are connected to integrators which store in capacitors information regarding the intensity of the light passing through the corresponding slit during a specific time. At the end of this time, each capacitor is connected in turn to a valve-voltmeter by means of a channel selector. The valve-voltmeter embodies a digital counting technique and presents information regarding the percentage content of any particular element in the form of a number. The instrument can be used for determining the metal content of lubricating oils. H. G. M. SPRATT

545.822

7487. Flame photometry with standard line calibration. R. HERRMANN. *Optik*, **12**, *No.* 4, 189–95 (1955) In German.

A test solution containing Na, K and Ca is fed into the flame with a standard Li solution. Four wavebands are selected by four filters and photocells which are arranged to indicate the ratios Na/Li, etc. Sensitivities are: Na, 2×10^{-10} g; K, 5×10^{-10} g; Ca, $1{\cdot}5\times10^{-9}$ g. Sources of error are discussed, particularly effects of varying viscosities and surface tensions of solutions. G. F. LOTHIAN

545.823

7488. Automatic photoelectric ultraviolet analyzer for continuous chemical analysis of process streams. L. G. GLASSER. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 556–63 (*July*, 1955).

An automatic photoelectric analyser, the counterpart of infrared process-stream analysers, has been developed for recording the concentration of an ultraviolet-absorbing component in a non-absorbing mixture of liquids or gases. Radiation sources, filters, and phototubes are interchangeable to provide various monochromatic radiations, or a simple monochromator can be attached to provide any wavelength from 220 to 1 200 mμ. The concentration range of the analyser can be selected by choice of interchangeable cells of lengths from 0·001 to 7·5 in., and by choice of shutters of various absorbance ranges in an optical balancing system. The absorbance range is usually restricted to values between 0·01 and 0·2. Sustained high accuracy is achieved by employing a ratio-detecting, phototube bridge circuit that eliminates erroneous readings caused by source fluctuations, and by employing an automatic standardizing system that periodically restores the initial calibration of the instrument and compensates for drift caused by fouling of windows of the sample cell and for other commonly encountered drifts. High concentrations, on the one hand, or concentrations in parts per million, on the other, can be recorded, and several typical applications are listed. A.

545.824

7489. On the physical basis of localized [ponctuelle] analysis by X-ray spectrography. R. CASTAING AND J. DESCAMPS. *J. Phys. Radium*, **16**, *No.* 4, 304–17 (*April*, 1955) In French.

The method for the determination of the chemical composition of a volume of the order of $1\mu^3$ of a specimen is by analysing the X-rays emitted when the region is bombarded by an electron beam. Measurements were made on the influence on the sensitivity of the method of specimen thickness and backing. J. HUGHES

545.827

7490. Analysis of fluorinated polyphenyls by mass spectrometer. P. BRADT AND F. L. MOHLER. *Analyt. Chem.*, **27**, *No.* 6, 875–7 (*June*, 1955).

A mass spectrometric method has been used to investigate the molecular weight and chemical composition of some fluorinated polyphenyls. The polymers were evaporated from a tube furnace directly into the ionization chamber of a mass spectrometer and mass spectra recorded as the furnace temperature was increased step by step. Mass spectra of polymers made from *p*-dibromotetrafluorobenzene showed molecules of formula $(C_6F_4)_nBr_2$ with n ranging from 3 to 6. Polymers made from the diiodo compound gave ions with as many as eleven phenylene rings with or without one or two iodine atoms attached to the chain. Molecule ions are predominant in these mass spectra; this simplifies the interpretation of results in terms of molecular weight distribution. A.

CRYSTALLOGRAPHY 548

548.3 : 536.424.1

7491. On the question of obtaining a metastable modification of thallium. É. I. ABAULINA AND N. V. ZAVARITSKIĬ. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 250 (1955) In Russian.

S. Sekito [*Z. Kristallographie*, **74**, 189 (1930)] reported that the high-temperature modification of thallium had been obtained in a metastable state by quenching. This observation could not be confirmed although several types of quenching were tried. A. L. MACKAY

548.5

7492. An account of an investigation of recrystallization processes. Z. MORLIN. *Acta phys. Hungar.* **4**, *No.* 3, 197–208 (1955) In German.

The growth of crystals in compacts of fine NaCl powder under pressures 1 000–20 000 kg/cm^2 at temperatures from 20–750°C is described. The smooth surface was etched in 94% alcohol to exhibit grain boundaries and other structures. Many of the crystallites with square faces showed diagonal markings, and some showed growth pyramids. It is con-

cluded that there is strong evidence for the Kössel mechanism of layer growth. W. M. LOMER

548.5

7493. Fibre-like growth forms in the electrocrystallization of silver. L. GRAF AND W. MORGENSTERN. Note in *Z. Naturforsch.*, **10a**, *No.* 4, 345–6 (1955) In German.

States that experiments to be described elsewhere show that two essentially different types of fibre-like growths, band and needle types, form on Pt or Ag cathodes of 3–15μ dia. in an aqueous $AgNO_3$ electrolytic solution. A current of 10^{-8}–10^{-6} ampere is required. Additions of KNO_3 or KCl do not affect the growth, whereas KI, KBr or KCN completely prevent it. The interlaced band growth consists of a monolayer on the cathode surface, while the needle form grows with constant rectangular cross-section in any direction into the electrolyte. Details of the size, structure and boundary surfaces of the needles are given. S. WEINTROUB

548.5

7494. Growth lamellae on copper crystals. L. GRAF AND L. R. HELL. Note in *Z. Naturforsch.*, **10a**, *No.* 4, 346 (1955) In German.

Observations made on the crystals to determine the relation of the lamellae to the crystallographic structure are described. The long crystals were grown by slow solidification from the melt under a protective atmosphere in graphite troughs slightly inclined to the horizontal. The surfaces of the crystals were strongly reflecting with coloured opalescent regions and the curved ends of the crystals gave clear pictures from which the symmetry of the poles and the various lamellar systems could be determined. Details of these systems, together with photographs, are given. S. WEINTROUB

548.5

7495. On the observation of a new type of relief on the surface of crystals of silicon carbide. R. JOUTY. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1713–15 (*April* 25, 1955) In French.

Describes and illustrates unexplained appearance of uniform furrows with sharp edges, 1–20μ wide and depths up to 10^3 Å, approximately parallel to the principal crystallographic axes, on about 1% of crystals studied when examined by phase-contrast microscopy. S. WEINTROUB

548.5

7496. Some observations on growth and etching of crystals with the diamond or zincblende structure. E. BILLIG AND P. J. HOLMES. Letter in *Acta cryst.*, **8**, *Pt* 6, 353–4 (*June*, 1955).

Single crystal dendrite plates of Ge exhibit systematic differences in perfection and etching properties between the main {111} bounding faces. Growth always occurs in the general [$\bar{1}\bar{1}$2] direction, the more perfect dendrite face being taken as (111). Explanations are given in terms of atomic bonding. J. FRANKS

548.5

7497. Some observations on surface phenomena appearing on lead single crystals. H. A. ATWATER, A. R. LANG AND B. CHALMERS. Note in *Canad. J. Phys.*, **33**, *No.* 6, 352–3 (*June*, 1955).

The surface of single crystals grown in air, but carefully kept free of oxide film by scraping the melt, shows step structures on the surface if this is roughly {111} or {100} type. The broad surface of the step is then very closely the corresponding low-index plane. W. M. LOMER

548.5

7498. On producing thin single crystal foils of aluminium which have any desired crystallographic orientations. H. FUJIWARA AND T. ICHIKI. *J. Phys. Soc. Japan*, **10**, *No.* 6, 468–71 (*June*, 1955).

Using T. Fujiwara's method, the authors have succeeded in producing the aluminium single crystal foils ($0{\cdot}06 \times 5 \times 100\,mm^3$, 99·53% in purity) having definite crystallographic orientations; for example, they are orientated in [110]–(110) or [110]–(100) or D_s or D_d, etc. It was found that the easiness with which a single-crystal foil was produced was remarkably different according to its crystallographic orientation. For the specimens D_s and D_d, it was also found that the bending behaviours caused by a mechanical shock were different from each other. A.

548.5 : 538.24

7499. Crystal growth and coercive forces of variously prepared Ni powders. W. G. COURTNEY. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1174 (*June*, 1955).

Ni powder was prepared from aqueous solutions of $NiSO_4$, NH_3 and $(NH_4)_2SO_4$ in sealed tubes at 185–225°c, with H_2 or NaH_2PO_2 as reducing agents, under magnetic fields (m.f.) of 0–1 200 Oe. With H_2, 10–50μ particles were obtained with a coercive force of 17 ± 5 Oe, independent of m.f.; with NaH_2PO_2, the Ni appeared as filaments 1–3μ wide and varying from 50–500μ in length as the m.f. was increased from 0–1 200 Oe, the coercive force increasing from 75 ± 5 to 110 ± 10 Oe. J. FRANKS

548.5 : 539.185.9

7500. Effect of reactor irradiation on the white-to-grey tin transformation. J. FLEEMAN AND G. J. DIENES. *J. appl. Phys.*, **26**, *No.* 6, 652–5 (*June*, 1955).

The effect of low-temperature (liquid nitrogen) reactor irradiation on the white-to-grey tin transformation has been investigated. It was found that, compared to an unirradiated pure sample, the transformation, measured by dilatometry, is drastically accelerated by prior irradiation. The irradiation apparently eliminates the normally very long induction period. The kinetic behaviour of reactor irradiated samples and of samples seeded with grey tin were found to be qualitatively similar. These results indicate that the defects introduced into white tin by reactor irradiation serve as nuclei, or at least embryos of nucleation, for the subsequent phase transformation. Whether point defects, their aggregates, or the strains surrounding the displaced atoms are responsible for the artificial "seeding" cannot yet be decided. Reactor irradiation appears to be a promising new tool for studying nucleation and growth processes since quite uniform artificial nucleation can be accomplished this way. A.

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

7501. A three-dimensional face-centred cubic model for the study of crystal phenomena. P. R. ROWLAND. *J. Inst. Metals*, **83**, *No.* 10, 455–9 (*June*, 1954–55).

The model, containing 10^3–10^4 lattice units, is rapidly and accurately assembled by pouring steel ball-bearings into a suitable transparent mould. Manipulation of the model has revealed a hitherto unsuspected lattice transformation, which results in the production of two new face-centred lattices bearing a twin relationship to each other but not to the original lattice. A corresponding transformation from face-centred cubic to close-packed hexagonal is also inferred. The model provides analogues of melting and annealing, and the effect of adding spheres of different sizes is described. In some cases these do not affect the lattice; nevertheless, only distortion-free, "solute"-free lattices undergo transformation without disruption, so that this affords a mechanism for the selection of portions having a perfect lattice. Limited experiments using bubbles indicate that with elastic, cohesive spheres transformation may be initiated at a surface or other discontinuity and may proceed as a wave instead of by co-operative movement of the whole lattice, with consequent lowering of the activation energy required. Such transformations in a real crystal could involve blocks of only a few hundred atoms but, since these would have perfect lattices, interpretation of recrystallization data offers a possible means of investigating their existence. A.

548.7 : 539.155.4

7502. Comments on Straumanis' concepts regarding Avogadro's number. E. R. COHEN AND J. W. M. DUMOND. Letter in *Phys. Rev.*, **98**, *No.* 4, 1128–9 (*May* 15, 1955).

Straumanis [Abstr. 2861 (1954)] suggested the definition of Avogadro's number with respect to a standard crystal, as measured values show a large discrepancy, and as the crystallographer is mainly interested in the Siegbahn–Avogadro number (N_s'). Here it is pointed out that indirect methods give very accurate values for N, though not necessarily for N_s'. The indirect values of N are therefore compared with direct values of N_s'. It is shown that there is a large discrepancy between the values found, and that the crystal density X-ray diffraction method gives the best single determination of N_s', though a least-squares adjusted value is probably superior still.

A. J. TAYLOR

548.7

7503. Successive orientational transitions with the discontinuous model. S. HOSOYA. *Sci. Pap. Coll. Gen. Educ. Univ. Tokyo*, **4**, *No.* 2, 93–101 (*Dec.*, 1954).

Shows that if the orientations of the rotators about their axes are taken to be discontinuous results are obtained which agree qualitatively with those obtained by Krieger and James [Abstr. 7854 (1954)] assuming continuous orientations. The calculations are for a square lattice using the Bragg–Williams approximation. E. P. WOHLFARTH

548.7

7504. Frequency spectrum of vibrations of a crystal lattice. E. W. MONTROLL. *Amer. math. Monthly*, **61**, *No.* 7, *Pt II*, 46–73 (1954).

A review of recent developments in the analysis of the spectrum. It is emphasized that the frequency distribution function is expected to have singularities. A simplified interpretation is given of the paper by van Hove [Abstr. 4473 (1953)]. Numerous examples illustrate the existence and number of singularities, especially for anisotropic crystals.

MATHEMATICAL REVIEWS

548.7 : 536.631

7505. Frequency spectra of free lattices and particle size effects on the heat capacity of solids. D. PATTERSON. *Canad. J. Chem.*, **33**, *No.* 6, 1079–87 (*June*, 1955).

The effect of particle size on the heat capacity of solids has been investigated using lattices with free boundaries as models. A monatomic lattice shows a low temperature effect associated with the acoustic modes. This can be compared with results obtained from a continuum model. With a diatomic lattice, however, an effect is also associated with the optical modes and is apparent at higher temperatures. The possibility that this latter effect can explain some recent experimental results is examined. A.

548.7

7506. Concerning calculations on the polaron by direct variational methods. S. I. PEKAR. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 5(11), 651–3 (1954) In Russian.

The author discusses the interpretation of his calculations, which employed the adiabatic approximation, by Lee and Pines [Abstr. 1248 (1953)] and by Lee, Low and Pines [Abstr. 4475 (1953)]. Lee *et al.* claim to have obtained a lower value for the energy of the lowest state than Pekar, who replies that this conclusion is based on an unjustified comparison of their q–m theory with his semi-classical theory. Pekar's q–m theory [Abstr. 2069 (1950)] gives a lower value than that of Lee *et al.* Finally he discusses the significance of values for the effective mass of the polaron obtained by variational methods.

J. M. RADCLIFFE

548.7 : 539.3

7507. The theory of the elasticity of crystals. K. S. VISWANATHAN. *Proc. Indian Acad. Sci. A*, **41**, *No.* 3, 98–116 (*March*, 1955).

Review of earlier work. See Abstr. 859, 9745 (1954). J. E. CAFFYN

548.7

7508. The excited states of an atomic electron in a one-dimensional crystal lattice. T. HAYASI AND S. OKADA. *Sci. Rep. Tôhoku Univ. First Ser.*, **37**, *No.* 4, 331–8 (*Dec.*, 1953) In German.

The potential energy of the electron is represented as a deepening of the existing rectangular potential trough. A discreet eigenvalue of higher energy than the mean inner potential of the crystal exists in each forbidden energy band and the corresponding eigenfunction falls away exponentially on each side of the atom considered. A. E. DE BARR

548.7

7509. A type of electron state at a crystal defect. T. HAYASI AND T. SAGAWA. *Sci. Rep. Tôhoku Univ. First Ser.*, **37**, *No.* 4, 339–48 (*Dec.*, 1953) In German.

Eigenvalues for a one-dimensional lattice containing a single defect are evaluated, using a square wave potential with one well of smaller depth as defect. It is found that there are bound states with energies in the forbidden zones of the perfect structure. These functions are given in detail. W. M. LOMER

548.7

7510. On the formation of dislocation networks in some crystal lattices. F. E. FUJITA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **7**, *No.* 1, 50–5 (*Feb.*, 1955).

As in a preceding paper [Abstr. 11542 (1954)], based upon the assumption that dislocations initially formed in a solidified crystal lattice are small rings of a definite type such as proposed by Seitz, the subsequent growth and mutual connection of the dislocation rings and the eventual formation of networks are geometrically discussed in reference to some typical crystal lattices. The results would be available for surmising probable features of the dislocation networks. A.

548.7

7511. Lattice resistance to dislocation motion at high velocity. E. W. HART. *Phys. Rev.*, **98**, *No.* 6, 1775–6 (*June* 15, 1955).

Dissipative effects at higher velocities, due to coherent collisions of dislocations with the lattice sites, have been estimated and found to be too small to limit the dislocation velocity. A.

548.7

7512. Ionic conductance and disorder of silver chloride containing impurities. I. EBERT AND J. TELTOW. *Ann. Phys.* [*Leipzig*] **15**, *No.* 5–6, 268–78 (1955) In German.

The electrical conductivity of AgCl with additions of $CdCl_2$, $PbCl_2$, CuCl and Ag_2S was measured in the mixed crystal region between 200°c and the melting point. The concentration of defects and their mobility were derived and conclusions drawn concerning the interaction and energy values of the defect sites. The significance of an anomalous increase in the conductivity near the melting point is discussed. W. GOOD

548.7

7513. Photochemical coloration in alkali-halide crystals at high temperatures. G. MIESSNER. *Z. Phys.*, **141**, *No.* 1–2, 111–21 (1955) In German.

The effect of H^- ions sensitizing the X-ray coloration of KBr at 430°c is studied in relation to the characteristics of the photocurrents observed.

G. F. J. GARLICK

548.7

7514. *F*-centres in silver halide crystals. P. V. MEĬKLYAR. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 252–3 (1955) In Russian.

A recent paper of Grenishin [Abstr. 853 (1954)] asserts that the absorption band in AgBr at $\lambda \simeq$ 420–430 mμ reported initially by author and Putseiko is not associated with *F*-centres. The assertion is based on the band width independence of temperature and on the absence of Br vacancies. The first assertion is not true. Grenishin takes data from experiments with a limited temperature range. But the author's experiments with Shimanskiĭ [Abstr. 5087 (1955)] show that a change of temperature of from 90°–100°c to 300°c produces a change of band width of 1·6 to 1·7 times, and to 408°c by 1·8 to 1·9 times—a change similar to that which occurs with the *F*-centre band in alkali halides. Further, Br vacancies are not caused in AgBr, as in alkali halides, by a Schottky mechanism. Owing to the marked homopolar binding and close packing in Ag halides electron transfer can take place from a halide ion to any of the surrounding Ag ions with consequent separation of a Br atom, and formation there of an *F*-centre. The energy of activation of such a process is approximately 0·15 eV [Abstr. 5087 (1955)]. Owing to the small energy, the *F*-band overlaps the fundamental. J. EWLES

548.7

7515. Thermal bleaching of color centers. A. HALPERIN AND A. BRANER. Letter in *Phys. Rev.*, **98**, *No.* 4, 1135–6 (*May* 15, 1955).

A confirmation and extension of previous studies [Abstr. 11549 (1954)] shows that no restoration of *F*-centres takes place during warming of coloured KCl crystals from low temperatures as suggested by Hesketh and Schneider [Abstract 7863 (1954)]. Thermoluminescence peaks are found to correlate with bleaching characteristics. Results show that several activation energies are involved in the thermal bleaching of *F*-centres in KCl. G. F. J. GARLICK

548.7

7516. Microwave resonance and the electronic structure of colour centres and impurity states in solids. C. KITTEL. *Defects in crystalline solids* [*Bristol*] 33–7. See Abstr. 5707 (1955).

A survey of studies of resonance in KCl containing *F*-centres and in *n* and *p* type Si, particularly with Li impurity. The importance is stressed of r.f. saturation of resonance lines as a means of distinguishing their inhomogeneous nature and of distinguishing conduction electron from impurity-centre resonance.

G. F. J. GARLICK

548.7 : 535.371

Current problems in crystalline luminescence. *See Abstr.* 6941

548.7 : 537.311.31

The electrical resistance and crystalline structure of the alloys Au_3Mn and AuMn in the temperature range −183 to 700°c. *See Abstr.* 7022

548.73/.74

X-ray and electron investigation of materials. *See also under* "Structure of solids." Decimal classification 539.26/.27

548.73

7517. The application of an X-ray method to the study of lattice bending. J. INTRATER AND D. EVANS. Letter in *Acta cryst.*, **8**, *Pt* 6, 357–8 (*June*, 1955).

The use of a high-resolution double-crystal diffractometer enables one to distinguish between lattice bending and fragmentation into small grains with a series of neighbouring orientations. In this way a zinc single crystal quenched from 400°c was examined and was shown to have been partly broken into small grains. A. R. STOKES

548.732

7518. Friedel's law in the dynamical theory of diffraction. S. MIYAKE AND R. UYEDA. *Acta cryst.*, **8**, *Pt* 6, 335–42 (*June*, 1955).

The significance and validity of Friedel's law are critically discussed by means of the dynamical theory of diffraction. It is proved that in some cases diffraction phenomena are not invariant under the operation of inversion exerted on the crystal; this means that Friedel's law fails. The cause of the failure is not the effect of absorption, but is found in the dynamical relation of reflections which are excited simultaneously. A.

548.732

7519. Number of X-ray diffraction groups. W. NOWACKI. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1172 (*June*, 1955).

See Abstr. 6127 (1954). It is shown that the number of diffraction groups depends on the definition used. If the Laue symmetry and the absent spectra alone determine a diffraction group, then there are 120 such groups. A. R. STOKES

548.732

7520. Crystallographic formalism 1B: Reply to Nowacki's letter "The number of X-ray diffraction groups." C. D. WEST. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1172 (*June*, 1955).

See preceding abstract. Two different concepts concerning the number of kinds of crystal units that can be distinguished by X-ray diffraction have already been advanced. The author now adopts the names extinction unit for one concept and diffraction unit, instead of diffraction group, for the later concept [see Abstr. 6127 (1954)]. An extinction unit is explained in *International Tables for X-ray Crystallography*, p. 52 (1952): this note defines the diffraction unit. More definite meanings are also assigned to the Laue symmetry symbol and the lattice symbol and mention made of the advantages of the adoption of the ideas proposed. H. G. JERRARD

548.732.2

7521. Bragg reflexion of polarized X-rays from a perfect absorbing crystal. K. S. CHANDRASEKHARAN. Letter in *Acta cryst.*, **8**, *Pt* 6, 361–2 (*June*, 1955).

Ratios of integrated intensities of reflection from calcite for two directions of polarization were found to agree better with theoretical values for a perfect absorbing crystal than for a mosaic crystal.

A. R. STOKES

548.733

7522. A Weissenberg camera for use at constant temperatures between about −150°C and 300°C. A. KREUGER. Letter in *Acta cryst.*, **8**, *Pt* 6, 348–9 (*June*, 1955).

The specimen is cooled by a stream of cooled nitrogen, whose temperature is recorded as it issues from a Dewar tube near the specimen. Arrangements for protecting the specimen and the camera are described. For high temperatures a stream of electrically heated nitrogen is used. A. R. STOKES

548.734

7523. The optical harmonic synthesizer and its possibilities. I. G. VON ELLER. *Bull. Soc. Franç. Minéral. Crist.*, **78**, *No.* 1–3, 157–213 (*Jan.–March*, 1955) In French.

The instrument is a two-dimensional Fourier synthesizer using photographic summation [see Abstr. 5002 (1951)]. Questions of uniformity of illumination, effect of reciprocity failure in the recording film, width of the light source, etc., are considered. The operation of the instrument is described, and its application to Fourier projections, Fourier sections, partial projections, determination of real and imaginary parts of structure factors, superposition of Patterson series, difference series and derivative functions. The construction is described in some detail. A. R. STOKES

548.734 : 537.311.33

The study of semiconductor crystal perfection by X-ray diffraction methods. *See Abstr.* 7039

548.734.84

7524. The distribution of the mean intensity of a finite group of reflexions. E. STANLEY. Letter in *Acta cryst.*, **8**, *Pt* 6, 351–2 (*June*, 1955).

It is shown that the distribution of the mean of n reflection intensities from an acentric crystal is the same as the distribution of the mean of $2n$ intensities from a centric crystal. Some consequences and applications are discussed. A. R. STOKES

548.735

7525. The chromatic error in small-angle X-ray scattering analysis. K. KRANJC. *Period. math.-phys. astron.* [*Zagreb*] **9**, *No.* 3–4, 167–78 (1954) In Serbo-Croat with summary in English (2 *pp.*).

An attempt is made to derive expressions which can be used to correct the observed small-angle X-ray scattering curves for errors due to the primary beam not being strictly monochromatic. The correction depends on the spectral energy distribution in the primary beam and on the absorption coefficient of the scattering material. It is necessary to consider each experimental arrangement separately. As an example of the usefulness of the proposed correction the scattering of Cu $K\alpha$ (nickel-filtered) radiation from finely divided aluminium hydroxide is considered in detail. J. IBALL

548.735

7526. The collimation error of circular apertures in small-angle X-ray scattering. K. KRANJC. *Period. math.-phys. astron.* [*Zagreb*] **9**, *No.* 3–4, 179–90 (1954).

A theoretical treatment of the effect of the finite size of a circular collimator on the small-angle X-ray scattering from colloidal materials. It is concluded that it is too complicated to calculate the correct intensity distribution $I_0(x)$ from the observed distribution $I(x)$ but the theoretical expression for $I_0(x)$ is derived and it can be used in an empirical manner to correct the observed scattering curves. Thus a corrected value for the particle size of the scattering material can be computed. J. IBALL

548.735

7527. X-ray studies of long chain compounds solidified under an alternating electric field. M. IDA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 4, 318 (*April*, 1955).

Eight compounds were used; each was solidified under a direct electric field and under alternating fields at frequencies 60 c/s and 300 kc/s. The X-ray diffraction evidence on the presence or absence of orientation is tabulated. A. R. STOKES

548.735.2

7528. The weighting of intensities for statistical surveys. E. STANLEY. Letter in *Acta cryst.*, **8**, *Pt* 6, 356–7 (*June*, 1955).

In space-groups other than $P1$ and $P\bar{1}$, there is no single intensity-distribution function: the reflections must be divided into groups, each of which has its own distribution. This note stresses the importance of proper weighting of these groups for the determination of temperature factor, the factor for conversion to the absolute scale of intensities, and the space-group. A. R. STOKES

548.735.4

7529. A comparison of optical methods and difference synthesis in the location of hydrogen. J. F. MCCONNELL. *Acta cryst.*, **8**, *Pt* 6, 308–10 (*June*, 1955).

A comparison has been made between optical methods of testing possible positions of hydrogen atoms in a crystal and the more objective method of a difference synthesis. The (010) projection of diphenylene naphthacene was used in the investigation. The results show that the optical methods give a quick guide, but that the difference synthesis is more definite. Optical methods can, however, be used for non-centrosymmetrical projections, whereas the difference synthesis cannot. The inclusion of hydrogen in the structure-factor calculations for diphenylene naphthacene reduced the agreement residuals from 0·18 to 0·11 for the ($h0l$) zone and from 0·21 to 0·14 for the ($0kl$) zone. This has important implications concerning the lengths of C–C bonds. A.

548.735.4 : 535.343 : 535.375.5

7530. Locating of hydrogen in crystals by means of infrared, hyperfrequency and Raman spectrometric methods. M. MAGAT. *J. Chim. phys.*, **52**, *No.* 3, 272–8 (*March*, 1955) In French.

The latest data on the hydrogen-oxygen distances are used to show that hydrogen is always in an asymmetric position, except for short bonds (like KHF_2). Intermediate cases are discussed in detail. The relation between frequency and length of hydrogen bond as given by Rundle and Parasol [Abstr. 1010 (1953)] has been extended to new cases, and a suggestion is made for its use in the study of structure. 88 references. C. TURNER

548.735.4

7531. A relationship among the structure-factor magnitudes for $P1$. H. HAUPTMAN AND J. KARLE. Letter in *Acta cryst.*, **8**, *Pt* 6, 355 (*June*, 1955).

A statistical relation between magnitudes of structure factors is obtained, valid for the case in which there are a known number of identical point atoms per unit cell and no two interatomic vectors coincide. A. R. STOKES

548.735.44

7532. On the determination of the atomic scattering factor on the basis of the measured structure factors by using Fourier series. U. KORHONEN. *Ann. Acad. Sci. Fennicae AI, Paper* 182, 6 *pp.* (1955).

An expression is derived, consisting of a sum of structure factors multiplied by coefficients. It is applied to rocksalt to give the atomic scattering factor of the Cl^- ion, in reasonable agreement with the theoretical curve. A. R. STOKES

548.735.44

7533. A simplified computation technique for structure refinement by means of two-dimensional f_0–f_c synthesis. E. HARNIK. Letter in *Acta cryst.*, **8**, *Pt* 6, 362–3 (*June*, 1955).

A rapid method is given for the computation of a Fourier synthesis only at points near atomic positions, using Beevers–Lipson strips. A. R. STOKES

548.735.46

7534. The interpretation of Patterson functions: an application of the superposition method. J. DONOHUE AND J. H. BRYDEN. *Acta cryst.*, **8**, *Pt* 6, 314–16 (*June*, 1955).

The superposition method of solving Patterson functions was applied, without any prior identification of the nature of any of the Patterson peaks, to the ($hk0$) projection of nitroguanidine. After preliminary considerations concerning the molecular orientation, the correct structure was quickly obtained without any additional assumptions. The method should be of use generally for crystals in which the orientation, but not the position, of a group of atoms of known structure, such as a benzene ring or a carboxyl group, can be deduced. A.

548.736.3

7535. Contribution to the study of metallic hydrides. The lanthanum-hydrogen system. B. DREYFUS-ALAIN. *Ann. Phys.* [*Paris*] **10**, 305–62 (*March–April*, 1955) In French.

A detailed X-ray and volumetric study of the hydrogenation of pure La on samples weighing a few mg only is reported. The parameters of pure La are quoted as $a = 3{\cdot}74$, $c = 6{\cdot}06$ Å for the h.c.p. low-temperature phase, and $a = 5{\cdot}292$ Å for the high temperature f.c.c. phase. The hydrides are f.c.c. and the lattice parameter rises to 5·690 for deuterium and to 5·694 for hydrogen for all pressures of gas greater than a few mm Hg. The uncertainty of parameter measurement after rapid reaction at fixed pressure (at temperature ~350°C) prevented detailed following of lattice parameter v. composition. The formulae LaH_2 and LaH_3 are both possible. A comparison with the transition metal hydrides is made. W. M. LOMER

548.736.3

7536. Variation in the lattice constant of evaporated potassium chloride. Y. FUKANO. *J. Phys. Soc. Japan*, **10**, *No.* 6, 420–4 (*June*, 1955).

The lattice constant of evaporated KCl crystals was measured with an accuracy of 0·01% using gold foil as a standard. The lattice constant of gold foil was calibrated in terms of TlCl and was found in agreement with the X-ray value. Spacings of KCl measured just after evaporation are larger than the

X-ray value by about 0·15%, provided the size of KCl crystals are larger than 150 Å. Spacings decrease when evaporated specimens are exposed to the air or are heated in vacuum. The lowest value of lattice constant obtained in this experiment is in agreement with the X-ray value within the experimental error. A.

548.736.3

7537. The crystal structure of WAl_5. J. Adam and J. B. Rich. *Acta cryst.*, **8**, *Pt* 6, 349–50 (*June*, 1955).

548.736.4

7538. Proton resonance in barium chlorate monohydrate. R. D. Spence. *J. chem. Phys.*, **23**, *No.* 6, 1166 (*June*, 1955).

Proton resonance experiments show that the two H atoms of the H_2O are 1·56 Å apart and the H–H direction makes an angle 124 ± 1·5° with the *c*-axis. D. H. WHIFFEN

548.736.6 : 535.39

7539. The structure and optical behaviour of jadeite. C. V. Raman and A. Jayaraman. *Proc. Indian Acad. Sci. A*, **41**, *No.* 4, 117–20 (*April*, 1955).

The phenomenon of semi-transparency exhibited by the finer varieties of jadeite is discussed. X-ray diffraction studies and theoretical considerations based on wave-optics alike indicate that this is a consequence of the very small particle size of the crystallites forming the aggregate. A.

548.736.6 : 539.169

7540. The effect of nuclear radiation on the structure of zircon. H. D. Holland and D. Gottfried. *Acta cryst.*, **8**, *Pt* 6, 291–300 (*June*, 1955).

The effect of nuclear radiation from the decay of uranium, thorium and their daughter elements on the specific gravity, unit-cell dimensions and optical properties of zircon has been studied. During the course of the irradiation the specific gravity of zircon drops 16%, the material becomes isotropic and so disordered as to fail to yield recognizable X-ray diffraction peaks. It is proposed that the observed effects are predominantly due to the displacement of atoms by recoil nuclei and by high temperatures generated in the path of nuclear particles. The breakdown of the structure is envisaged as a four-stage process in which the structure is first saturated with displacements; the saturated structure then breaks down into crystallites of ordered zircon which ultimately break down into a glass. A.

548.736.6 : 539.132

An investigation of the nuclear resonance absorption spectrum of Al^{27} in a single crystal of euclase. *See Abstr.* 7258

548.74

7541. A neutron-diffraction study of the ferroelectric transition of potassium dihydrogen phosphate. G. E. Bacon and R. S. Pease. *Proc. Roy. Soc. A*, **230**, *No.* 1182, 359–81 (*June* 21, 1955).

Neutron-diffraction measurements demonstrate that the hydrogen atoms in the ferroelectric form of potassium dihydrogen phosphate are in ordered positions, in accordance with Slater's theory and the polar orthorhombic structure. The maintenance of a crystal as a single ferroelectric domain by application of an electric field along the *Z*-axis is illustrated, and the diffraction spectra show that reversal of the field direction produces a shift of the hydrogen atoms along the O–H–O bonds from one set of ordered positions to the other. A detailed study is made of the thermal motion of the hydrogen atoms at 77, 132 and 293°K, and it is found that the motion within the potential well defined by the KPO framework is practically independent of temperature and is due to zero-point energy. Parameters are determined for all the atoms at each temperature and discussed with reference to other published data. A.

548.74 : 539.185

7542. A spectrometer for single crystal neutron diffraction. G. E. Bacon and R. F. Dyer. *J. sci. Instrum.*, **32**, *No.* 7, 256–7 (*July*, 1955).

A description is given of an instrument for neutron crystallography, specially designed for measurements with single crystals. The small size is in marked contrast with that of the conventional spectrometers designed for powder diffraction methods. A.

548.74 : 539.219

7543. An electronographic study of the Bi–Se alloy system. S. A. Semiletov and Z. G. Pinsker. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 6, 1079–82 (1955) In Russian.

Binary alloys of Bi and Se were prepared as very thin layers (10^{-5} to 10^{-6} cm thick) by evaporation *in vacuo*. Three phases were identified from electron diffraction pictures. Phase I was rhombohedral with $a = 4·14 \pm 0·01$ and $c = 28·9 \pm 0·2$ kX. Reflections were strong when *l* was a multiple of 5. This compound was correlated with measurements by E. Donges [*Zeit. anorg. allg. Chem.*, **265**, 56 (1951)] and identified as Bi_2Se_3. The structural type is that of Bi_2Te_2S with parameters *z* (Bi) = 0·399 and *z* (Se) = 0·206. No evidence for a statistical structure was found. Phase II was also rhombohedral but showed strong reflections in layer lines with $l = 7$. Cell dimensions were $a = 4·22 \pm 0·01$ and $c = 40·4 \pm 0·3$ kX. From a comparison with the layer structure of phase I, phase II was identified as of composition Bi_3Se_4 with space group $R\bar{3}m$ and *z* parameters 0·428 for Bi, 0·139 for Se and 0·286 for Se_1, $z = 3$. The structure consists of 21 layers compared with 15 for Bi_2Se_3. Phase III was face-centred cubic with $a = 5·98 \pm 0·02$ kX and had the structure of NaCl and the composition BiSe. These three phases were stable over appreciable composition ranges with corresponding changes in cell dimensions. Their structures differ in the occupation of the octahedral vacancies: in Bi_2Se_3 2/3 are filled by Bi atoms, in Bi_3Se_4 3/4 are filled and in BiSe all vacancies are filled. A. L. MACKAY

GEOPHYSICS 55

550.341

7544. The form and laws of propagation of seismic wavelets. N. RICKER. *Geophysics*, **18**, *No.* 1, 10–40 (*Jan.*, 1953).

An attack has been made upon the problem of the form of the seismic disturbance which proceeds outward from the explosion of a charge of dynamite and the laws of propagation of this disturbance. A mathematical theory was developed about ten years ago and a small amount of experimental work carried out at that time encouraged further efforts. Recently an extensive series of experimental researches have been carried out in a sensibly homogeneous shale section, and as a result of these studies a rather clear understanding of the form and nature of the primary seismic disturbance, and its laws of propagation, has been obtained for shale. The results are in good agreement with the theory. A.

550.382

7545. The mineralogy of rock magnetism. G. D. NICHOLLS. *Advances in Phys.*, **4**, 113–90 (*April*, 1955).

An extensive review of the following topics: Methods of study of opaque minerals (X-ray powder photography, thermomagnetic investigations, chemical analysis); structure and properties of the following oxide minerals: magnetite, maghemite, haematite, ilmenite, ulvöspinel, Fe_3O_4–Fe_2TiO_4, $\alpha\,Fe_2O_3$–$FeTiO_3$, Fe_3O_4–Fe_2O_3, Fe_3O_4–$FeTiO_3$ solid solution series; effect of other cations on structure and properties; ferrimagnetic sulphide minerals (FeS_{1+x}); igneous, sedimentary and metamorphic rocks and their ferrimagnetic minerals (considered separately); stability of ferrimagnetic oxide minerals after initial formation; the phenomenon of reverse thermoremanent magnetization and its interpretation. 122 references.

E. P. WOHLFARTH

550.382

7546. Some theoretical aspects of rock-magnetism. L. NÉEL. *Advances in Phys.*, **4**, 191–243 (*April*, 1955).

Theoretical and experimental results have been compared for remanent magnetization, initial susceptibility, variation with applied field of thermoremanent magnetization (TRM), the ratio Q_k, of TRM acquired in a given field to the induced magnetization in this field and the additivity of partial TRM's for cases of small and large grains. Magnetic viscosity due to thermal agitation in small and large grains is examined. Expressions are obtained for magnetic viscosity in the range of Rayleigh's relations particularly when a demagnetizing field is present. The theoretical and experimental results on the irreversible decrease in isothermal remanent magnetization are quoted for small and large grains. Different reversing mechanisms are reviewed which could produce a TRM in the opposite sense to the field applied during cooling such as (1) negative Weiss–Heisenberg exchange forces, (2) reversal by diffusion involving ionic exchange between the two sub-lattices in a ferrimagnetic, by anomalous thermal variation in spontaneous magnetization or by diffusion with complete change of composition, (3) effects of the demagnetizing field, (4) reversal in mixtures of two constituents with different Curie points, and (5) reversal by segregation, allotropy and chemical alteration. Known examples are recalled.

R. S. READ

550.382

7547. Rock magnetism—geophysical aspects. S. K. RUNCORN. *Advances in Phys.*, **4**, 244–91 (*April*, 1955).

Rock magnetism is considered as a means to extend the knowledge of physical properties of the earth through geological time but mainly results obtained since Nagata's review (1953) are discussed. The field and laboratory tests of magnetization and its stability are first examined, and the palaeomagnetism of holocene varied clays and quaternary lava flows of different geological ages is reviewed. The origin of reversed magnetization, its theoretical interpretation and changes in its direction and the hypotheses of continental drift and polar wandering to explain them are examined. It is concluded that (1) Néel's view that self-reversal could occur on change of temperature by two different mechanisms for lava flows and other igneous bodies holds only on the assumption that iron oxides no longer possess this property because of chemical or structural properties in them, (2) reversals occur also in sedimentary rocks. In summarizing (1) for igneous and sedimentary rocks older than tertiary, of proved stability, the magnetization is remote from the present geomagnetic field and tends to be constant through any geological epoch and over considerable distances, (2) magnetization of sediments is probably due to river currents with orientation and compacting during consolidation, (3) the remanent magnetizations of rocks of the same lithology possess similar properties and proof of stability as those sampled for palaeomagnetic properties, (4) direction of magnetization of formations in different continents of the same or similar age give roughly the same positions for the magnetic poles in those ages and, (5) appreciable polar wandering is indicated, but it is unnecessary to invoke appreciable continental drift to explain the palaeomagnetic results. R. S. READ

550.385 : 551.594.5

7548. On the electric field theory of magnetic storms and aurorae. H. ALFVÉN. *Tellus*, **7**, *No.* 1, 50–64 (*Feb.*, 1955).

The electric field theory is discussed and further developed. The basic assumption of the theory is that the sun emits beams of rarefied ionized gas which are electrically polarized. The electric field of the beam produces a discharge of Malmfors–Block's type around the earth. At the same time the electric field produces a variation in the cosmic ray intensity. The theoretical treatment starts by an analysis of the motion of charged particles in the equatorial plane of the earth under the action of the electric field. This phenomenon is supposed to be of basic importance. The motion produces space charge in certain regions. This charge is supposed to leave the equatorial plane along the magnetic lines of force. These two basic assumptions, which are supported by the model experiments, lead to a theory which gives a fairly good picture of magnetic storms and aurorae. In the earlier presentation of the theory the inertia of the beam was neglected. The theory gave a descrip-

tion of the main phase of a storm. The motion in the equatorial plane produces a clockwise ring current at about 7 earth-radii from which a discharge to the auroral zones takes place. In the present paper also the inertia of the beam is taken into account. The result is that a second ring current is produced, which flows anti-clockwise at about 30 earth-radii. This current which seems to account for the initial phase of a storm, should be associated with an *inner auroral zone* with a polar distance of 5°–10°. The importance of observing aurorae and magnetic disturbances in this region is stressed. A.

550.385 : 551.594.5

7549. Model experiments on aurorae and magnetic storms. L. Block. *Tellus*, **7**, *No.* 1, 65–86 (*Feb.*, 1955).

Model experiments on Alfvén's electric field theory of aurorae and magnetic storms have been performed. The transformation laws from nature to model are considered. It is concluded that a proper scaling down of every detail in nature is not possible. Only the most significant features are scaled down properly. It is shown that a mechanism like Alfvén's proposed auroral mechanism is very likely to be present in the model. In particular the conception seems to be experimentally confirmed, that space charge accumulated in the discharge region rather than destroy the whole pattern of motion, discharges along the magnetic field lines. A.

551.23 : 536.531

7550. A field instrument for measuring temperatures of natural boiling pools. Z. S. Garvitch. *J. sci. Instrum.*, **32**, *No.* 7, 261–3 (*July*, 1955).

A prototype instrument is described by which the temperature of natural boiling pools may be compared with the local boiling point of pure water. The difference in temperature is indicated by a meter on which changes of 0·02 deg. C are easily detectable. The power required is provided by a motor-cycle battery, and the whole instrument is mounted on a pack frame. A proposal for an improved lighter model of the instrument is included. The equipment may also have a use as an alpine height-finder. A.

ATMOSPHERE . METEOROLOGY 551.5

551.501.8

7551. Resolution in height of a radar pulse. V. G. Miles. *J. Meteorol.*, **12**, *No.* 2, 107–10 (*April*, 1955).

The resolution in height of a radar pulse is of interest in connection with the observation and interpretation of horizontally stratified echoes, and also in the comparison of values of echo intensity measured at different ranges and elevation angles. An analysis is made of the ability of a radar pulse to resolve, either completely or partially, the echoes from two closely spaced horizontal reflecting layers situated close to the radar. The general expressions obtained are illustrated graphically. A.

551.508.94

7552. Use, for the recording of the atmospheric electric field potential, of a Benndorf electrometer, originally having mechanical registration. S. Gandolfo. *Ann. Geofis.*, **8**, *No.* 1, 75–82 (*Jan.*, 1955) In Italian.

551.510.41

7553. The molecular diffusive rate of change of composition in the atmosphere. S. Chapman. *J. Meteorol.*, **12**, *No.* 2, 111–16 (*April*, 1955).

The atmosphere appears to be (within narrow limits) uniform in composition, as regards its permanent constituents, up to a height of at least 60 km. The vertical variations of pressure and temperature produce relative motion of the different constituents by molecular diffusion; these diffusive fluxes are calculated for an atmosphere uniformly mixed up to 80 km, and with the temperature distribution given by the Rocket Panel (1953). The downward pressure-diffusion flux of the heavier particles far exceeds the thermal-diffusion flux. But the rate at which molecular diffusion tends relatively to enrich or deplete any constituent at any height is proportional to the gradient of these fluxes, and in this respect the influence of thermal diffusion is comparable with that of pressure diffusion. It is inferred that if convection suddenly ceased throughout the atmosphere, at the outset the O_2 concentration would increase, and the He concentration would decrease at about 80 km. The rates of enrichment or depletion even at this level, however, are so small, compared to the total density there, that a period of many months of rest would be needed to bring about appreciable changes of composition. Some other aspects of atmospheric diffusion are also discussed briefly. A.

551.510.41

7554. Dissociation of oxygen in the upper atmosphere. E. T. Byram, T. A. Chubb and H. Friedman. *Phys. Rev.*, **98**, *No.* 6, 1594–7 (*June* 15, 1955).

The molecular oxygen content of the upper atmosphere between 110 and 130 km was determined by measuring the transmission of solar radiation in a narrow wavelength band from 1 425 to 1 500 Å. The radiation was detected by means of an ultraviolet photon counter flown in an Aerobee rocket. At 130 km the concentration of O_2 was 10^{10} per cm^3. On the basis of the Rocket Panel density scale, 12% of the atmospheric oxygen was still undissociated. A.

551.510.535

7555. Critical considerations on the *F* region of the ionosphere. P. Dominici and F. Mariani. *Ann. Geofis.*, **8**, *No.* 1, 103–20 (*Jan.*, 1955) In Italian.

The most notable aspects of the phenomenology of the *F* region of the ionosphere are discussed in the present note. From some general facts on the general character of the probable formation processes of the region, its behaviour is briefly illustrated and it is shown that the singularities which it presents are in substance those of the *F*2 layer; the physical interpretation is not simple. It is shown that the hypothesis of thermal dilation is insufficient to explain the seasonal and daily anomalies in its behaviour and the geographic distribution of the critical frequencies of the layer. The dynamo theory of Martyn, on the other hand, seems to account rather well for these anomalies under non-perturbed conditions. The possibility of the formation of a zone of high electronic

density from the superposition of $F1$ and "true" $F2$ layers is then considered. Nevertheless, such a superposition model, although quantitatively it can account for some of the anomalies of the $F2$ layer, is not quantitatively calculable, because of the difficulty in the correct interpretation of the virtual height $h'F2$; it is shown how an increase in $h'F2$ is, in some cases, accompanied by a decrease in the height of the layer. A.

551.510.535

Radio-wave propagation in the ionosphere. *See also under* "Electromagnetic waves and oscillations." Decimal classification 538.566.3

551.510.535 : 523.745

7556. Relations between the critical frequency of the $F2$ layer of the ionosphere at Fribourg and active centres on the sun during the years 1948–1951. P. Simon. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 11, 1192–3 (*March* 14, 1955) In French.

For any hour h of any day j, an ionospheric index I_{hj} is defined as the ratio of the critical frequency of the $F2$ layer at h, j to the mean of the critical frequencies observed at the same hour h on the days $j-13$ to $j+13$ inclusive. The mean value of I_{hj} for the noctural hours 00h to 04h is called I_N, and the mean for the diurnal hours 11h to 17h, I_D. Values of I_N and I_D are plotted against days from central meridian passage of a spot group, and averaged for (i) 97 spots of type Q (calm) and (ii) 73 spots of type R (active). No significant correlations are found for either I_N or I_D with the spots of type Q. With spots of type R, no significant correlation is found with I_D, but a significant diminution of I_N is found for the period from 2 to 6 days after central meridian passage. M. W. Ovenden

551.576 : 534.222.2

The propagation of explosion waves through supercooled clouds. *See Abstr.* 6831

551.579.5 : 621.317.79

7557. An instrument for measuring the moisture of soils. M. Borisov and S. Kŭnev. *Izv. Bulg. Akad. Nauk*, **3,** 119–26 (1952; publ. 1954) In Bulgarian, with summaries in Russian and German (250 words).

The instrument suggested uses the variations of the dielectric losses in a capacitor-type earth "electrode," indicated by variations of the grid current of a h.f. oscillator, for determining the moisture of soils, and also of other media such as flour and other food products, textiles, building materials, timber, etc. The instrument is simplified and improved by comparison with previous designs. It is necessary to combine the moisture measurement with temperature measurements and to calibrate the instrument for every possible soil temperature, but a graduation of the instrument for percent specific moisture content is possible and the results of the measurement are independent of the soil structure. B. F. Kraus

551.593.9

7558. Infra-red spectrum of the night sky near 10 000 Å. A. V. Jones. Letter in *Nature* [*London*] **175,** 950–1 (*May* 28, 1955).

Infrared spectrograms in the region, 9 500 Å to 11 000 Å obtained with the improved Kodak $IZ(2)$ emulsion (hypersensitized) show that the atmospheric emission in this region is due almost entirely to the O–H rotation-vibration band system. Agreement of measured with computed wavelengths is excellent. The Q branch of the (3, 0) band is definitely present, but abnormally weak. Neither of the O_2 (0, 2) and (10, 6) bands is present. Measured, and computed wavelengths of 26 emission features are tabulated. D. R. Barber

551.593.9

7559. Resonance absorption of sunlight in twilight layers. T. M. Donahue and R. Resnick. *Phys. Rev.*, **98,** *No.* 6, 1622–5 (*June* 15, 1955).

Solar radiation must pass at least once through the absorbing layer to reach the twilight zone of a layer of atoms scattering resonance radiation. The attenuation of the solar beam is calculated for resonance absorption and the resulting scattered intensity compared with the transparent layer model intensity for the same thickness of material. It is shown that in the case of sodium, the reduction in intensity for layers thicker than 10^9 atoms/cm^2 is too serious to permit the deduction of layer thickness from a simple theory which neglects imprisonment of resonance radiation. A.

551.594.12

7560. Chapman's photoionization theory in a non-isothermal atmosphere. F. Mariani. *Ann. Geofis.*, **8,** *No.* 1, 59–73 (*Jan.*, 1955) In Italian.

An atmosphere in which the temperature varies linearly with the height at least up to a certain altitude and thence assumes a constant value is considered. The results obtained for the ionization intensity in the two cases in which the atmosphere is supposed stratified in parallel planes (radius of the earth $= \infty$) or spheres concentric to the earth are practically coincident at least for zenith angles less than 60°. Notable differences are found in the form of the dependence of the ionization intensity and of the height of its maximum (or maxima) with respect to the original Chapman theory. A.

551.594.13

7561. The electrical conductivity of the earth's mantle. S. K. Runcorn. *Trans Amer. Geophys. Un.*, **36,** *No.* 2, 191–8 (*April*, 1955).

The rapid rise in electrical conductivity at depths of 700 km in the earth's mantle, inferred by S. Chapman and his collaborators from a study of the transient variations of the geomagnetic field, may be well explained on the hypothesis that the process of intrinsic semiconduction is of importance in this region. H. Hughes has demonstrated (1953) the various conduction processes occurring in olivine and similar minerals and has shown that the results fit in quantitatively with the observational data referred to above. An indirect method of estimating the effect of pressure on the process of intrinsic semiconduction has been attempted and does not appear to alter the view that the rapid rise in conductivity is, in essence, a temperature effect. From this work estimates can be made of the electrical conductivity of the lower part of the mantle, which agree with estimates inferred from the spectrum of the secular variation of the

geomagnetic field and the explanation of the irregular fluctuations in the length of the day. A.

551.594.22

7562. The fine structure of natural point-discharge currents. M. I. LARGE AND E. T. PIERCE. *Quart. J. Roy. Meteorol. Soc.*, **81**, 92–5 (*Jan.*, 1955).

A parallel investigation has been made of the discharge from an earthed point mounted at a height of 7 m and the electrostatic field mill. The natural point discharge is found to produce the same pulses as have previously been detected in the laboratory discharge [*Phys. Rev.*, **54**, 1078–84 (*Dec.* 15, 1938)] of a point-plane gap. The simple relation connecting the point discharge current with the applied field strength [*Meteorolog. Office, Geophys. Mem., No.* 68, 20 *pp.* (1936)] does not hold over short time intervals. Natural point discharge is shown to produce a characteristic television interference. R. H. GOLDE

551.594.221 : 541.126

Chemical and electrical explosions. *See Abstr.* 7453

551.594.221 : 621.316.98

7563. On the maintenance of current in the stepped leader stroke of a lightning discharge. C. M. SRIVASTAVA AND S. R. KHASTGIR. Letter in *J. sci. industr. Res.*, **14B**, *No.* 1, 34–5 (*Jan.*, 1955).

It is suggested that the *IR*-drop which has been postulated to explain the stepped nature of the lightning leader stroke is produced by the liberation of photo-electrons in the cloud which proceed down the channel to its tip. The magnitude of the current is calculated and is found to amount to $0{\cdot}022\times10^{-3}$ A in agreement with an earlier estimate by Loeb and Meek. R. H. GOLDE

551.594.5 : 550.385

On the electric field theory of magnetic storms and aurorae. *See Abstr.* 7548

551.594.5 : 550.385

Model experiments on aurorae and magnetic storms. *See Abstr.* 7549

551.594.5 : 550.385 : 523.72

7564. On the emission of electric currents from the sun. V. C. A. FERRARO. *Indian J. Meteorol. Geophys.*, **5**, *Special No.*, 157–60 (*Dec.*, 1954).

The influence of induction effects on the growth of solar currents is discussed and it is concluded that the maximum current that could be carried by a corpuscular stream would be too small to produce appreciable geomagnetic effects. R. A. NEWING

BIOLOGY 57/59

577.3 : 536.7

7565. The metabolic turnover and the maintenance of the low entropy level. M. SUGITA. Note in *J. Phys. Soc. Japan*, **10**, *No.* 4, 316–17 (*April*, 1955).

Continuation of previous work [Abstr. 4052–4 (1954)] in which the turnover of entropy and enthalpy are considered. F. E. HOARE

578.086 : 621.383 : 621.317.79

7566. An integrating microdensitometer for biological cells. E. M. DEELEY. *J. sci. Instrum.*, **32**, *No.* 7, 263–7 (*July*, 1955).

A photoelectric method for the rapid determination of the total absorption of biological cells is described. The image of the cell, formed by a microscope, is scanned by a mechanically-driven aperture behind which is mounted a photomultiplier. A logarithmic circuit is used in conjunction with an electric integrator giving a meter reading linearly related to the total absorption. The scanning time is 3 sec and it is possible to measure at least 40 cells per hour. The mean random error is $\pm2\%$ for most objects studied, and the error due to inhomogeneous distribution in one plane is negligible. Systematic error due to glare and other optical effects is $\sim2\%$. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84 : 628.97

7567. Influence of physiological optics on lighting practice. W. SINN. *Lichttechnik*, **7**, *No.* 5, 182–4 (*May*, 1955) In German.

The author points out certain lighting problems in which phenomena in the realm of physiological optics have to be taken into consideration. In particular he cites street lighting, where the glare effect of a source is due to size and brightness combined. Flicker is more noticeable at low than at high values of luminance. The transition from a region of high illumination to one of much lower illumination requires time for adaptation. J. W. T. WALSH

612.843.31

7568. Sensitivity of the eye to spectral radiation at scotopic and mesopic intensity levels. J. A. S. KINNEY. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 507–14 (*July*, 1955).

Spectral sensitivity curves were established for three intensity levels above scotopic threshold with a two-degree field placed ten degrees from fixation against a dark surround. These curves were compared with the minimum scotopic luminosity curve determined for the same retinal position for each observer. The results showed that (1) there is a range of intensities over which relative spectral sensitivity does not change appreciably from the scotopic luminosity function, (2) there are irregularities in these mesopic curves which may be attributed to cone activity, and (3) the first change in spectral sensitivity with increased intensity is found in the long-wavelength half of the spectrum. A.

612.843.31

7569. Some problems related to testing color vision with the Nagel anomaloscope. I. SCHMIDT. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 514–22 (*July*, 1955).

A discussion of some methodological and statistical problems in testing colour vision with the Nagel anomaloscope and an evaluation of records compiled during a period of four and a half years' research

work at the U.S. Air Force School of Aviation Medicine, Randolph Field, Texas. Following topics are dealt with: elimination of training effects and determination of the total number of readings required to detect specified minimum practical differences between individuals; application and frequency distribution of the anomalous quotient; determination of the normal matching range of mixtures and of comparison yellow; and test-retest reliability of the Nagel anomaloscope. A.

612.843.31

7570. Some quantitative aspects of an opponent-colors theory. I. Chromatic responses and spectral saturation. D. Jameson and L. M. Hurvich. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 546–52 (*July*, 1955).

Saturation discrimination is assumed to be dependent on the ratio of chromatic to achromatic components in the sensory response to a given wavelength. The usual methods of measurement do not, however, permit independent control of the chromatic and achromatic variables. On the basis of an opponent-colours theory of vision, a method is described for measuring directly and separately the spectral distributions of the chromatic components. A series of experiments is reported in which this method was used to obtain measures of the paired chromatic responses associated with the four primary spectral hues. Results are reported for two observers, 1° foveal test field, for an equal brightness spectrum (10 mL), and a neutral state of adaptation (10 mL). The measured chromatic responses, together with achromatic (luminosity) functions measured earlier for the same observers, are used to predict the form of the spectral saturation discrimination function. A.

612.843.5

7571. The stroboscopic effect and the barber-pole illusion. L. E. Dodd. *Amer. J. Phys.*, **22**, *No.* 6, 394–401 (*Sept.*, 1954).

Mathematically and experimentally this paper shows that the visual stroboscopic effect has as a limiting case the barber-pole illusion. The conclusion is reached with primary emphasis on physical stimulus rather than psychological, including physiological, response. The treatment is from the teaching standpoint. For readers unfamiliar with the stroboscopic effect its essentials are given in detail. A.

612.843.611

7572. Effects of exposure to various red lights upon subsequent dark adaptation measured by the method of constant stimuli. S. W. Smith, A. Morris and F. L. Dimmick. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 502–6 (*July*, 1955).

In order to answer a practical question as to the most effective red light to be used in military situations requiring dark adaptation, an experiment was undertaken to compare the effects of four "red" filters at constant brightness levels. It was obvious that with traditional methods of measuring dark adaptation, these effects could not be measured with sufficient accuracy to make comparisons. An application of the method of constant stimuli was developed which gave adequate accuracy of measurement. The results show differences in the effects of adapting to light having dominant wavelengths of 601, 626, 640, 675, 690 mμ and neutral. The maximum sensitivity differences occurred early in dark adaptation (before two minutes). Dark adaptation proceeded most rapidly following adaptation to 626 mμ. The maximum difference between neutral and 626 mμ was 0·5 log$\mu\mu$L and differences between the various "red" conditions ranged from zero to 0·22 log$\mu\mu$L. This application of the constant stimuli method gives results which may be more sensitive than the calibrations of standard instruments. A.

612.843.72

7573. Some experiments on the vision of virtual images. L. Ronchi and M. T. Zoli. *Atti Fond. Ronchi*, **10**, *No.* 2, 112–34 (*March–April*, 1955) In Italian.

Investigates the variation of the apparent visual size of objects seen by reflection at a semi-silvered glass plate, as a function of distance, for binocular observers. The observers give quite different responses, difficult to explain theoretically. Also the resolving power seems to be influenced by the variation of the distance, for monocular observers. Further, the variation of the apparent visual size of objects seen by a telescope is studied. The magnification influences the observers in a complicated manner. A.

612.843.721

7574. New observation of the Pulfrich effect. M. S. Katz and I. Schwartz. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 523–4 (*July*, 1955).

The Pulfrich effect has been characterized as a perception of depth produced by image disparity when the stimulus to one eye is less bright than that to the other. A method has been devised which permits ostensible binocular vision but gives a monocular stimulation to each eye in succession, so that no portion of the pathway of the oscillating stimulus is visible to both eyes at the same time. Under this condition, the perception of depth is still reported, thus damaging the latency hypothesis based on binocular vision as an explanation of the phenomenon. A.

612.843.721

7575. Relative contributions of disparity and convergence to stereoscopic acuity. A. A. Rady and I. G. H. Ishak. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 530–4 (*July*, 1955).

Stereoscopic acuities were determined with and without eye movement, following the experimental procedure used by Wright. Two illuminated apertures were used as the targets seen in the dark against a black background. Measurements were made for these targets separated horizontally for various visual angles up to 52° and for high, low, and unequal luminances. A critical study of the results showed that disparity was responsible for the greater part of stereoscopic acuity. The part played by eye movement (convergence movements), if any, appears to be constant and is of minor importance compared to the part played by disparity. A.

612.858.71

7576. On the frequency distribution of the human audibility threshold. E. Zwicker and W. Heinz. *Acustica*, **5**, 75–80 (1955) [= *Akust. Beih.*, *No.* 1 (1955)] In German.

The binaural and monaural thresholds of audibility

have been measured on 100 male and female students with a Békésy-audiometer. The resulting average threshold as well as the limiting curves below which are less than 10% and more than 90% respectively of all test results are given and compared with the results of other authors. Only in the frequency range below 500 c/s, the binaural thresholds run a little deeper than those for monaural listening. Above 500 c/s the two ears are at the threshold of audibility alternatingly. A.

612.858.71 : 591.185.5

7577. Auditory thresholds of the cat. W. D. Neff and J. E. Hind. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 480–4 (*May*, 1955).

The auditory thresholds of the cat have been obtained by the conditioned response method. Tests were made for frequencies from 62·5 to 60 000 c/s. The upper limit of the cat's hearing is in the neighbourhood of 60 000 c/s. A comparison of threshold curves for cat and man suggests that the cat may be slightly less sensitive than man for frequencies of 500 c/s and below. Sensitivity for the range 500 to 4 000 c/s is almost the same. For higher frequencies the hearing of the cat is distinctly superior to that of man. A.

.612.858.76

7578. The unusual amplitude dependence of the ear's nonlinear distortion. E. Zwicker. *Acustica*, **5**, 67–74 (1955) [= *Akust. Beih.*, *No.* 1 (1955)] In German.

The quadratic and cubic nonlinearities of the ear have been measured by a compensation method. The subjective perceptible difference tone is made to disappear by giving to the ear a tone of the same frequency adjustable in amplitude and phase. There results an exact quadratic law for the dependence of the quadratic difference tone on the amplitude of the primary tones, whereas the cubic difference tone decreases only very slowly with decreasing sound pressure of the primary tones. This behaviour of the cubic difference tone disagrees completely with the law of a simple parabola of third order. It is supposed that the ear has a symmetrical characteristic with a bend at about $\pm 0{\cdot}1\,\mu$bar. A.

612.858.76

7579. Statistical study of the differential auditory intensity sensitivity. R. Chocholle. *Acustica*, **5**, *No.* 1, 134–41 (1955) In French.

Response curves of the ear to intensity variation were studied, relatively to different intensity levels, at three frequencies. These curves, of sigmoid form, exhibit a steep slope; the louder the tone, the steeper the slope; at high intensities, they are asymmetrical. Differential thresholds seem not to depend on frequency, but on the other hand, they vary with intensity. A.

612.858.76

7580. The fusion of intermittent white noise. D. Symmes, L. F. Chapman and W. C. Halstead. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 470–4 (*May*, 1955).

Stimulus variables influencing the fusion of interrupted white noise have been re-examined in a single trained observer using repetition rate as the independent variable. Critical auditory decay times have been calculated for all observed fusion thresholds under the assumption that the cue for the perception of minimal flutter is a decay of one detectable step in the loudness of the interrupted signal during the off interval. These critical decay times are satisfactorily described by the value 120 msec (independent of intensity) when the burst duration in the interrupted signal is longer than a critical value (5 msec for this listener), but for shorter burst durations the decay times are much lower and exhibit a relationship to burst duration and intensity. A shift in the population of neural units activated under the latter conditions is postulated as an explanation. The range of individual differences in flutter fusion thresholds under standard conditions has been examined by the use of a tape recorded test requiring repeated discriminations of interrupted from continuous noise. From a sample of 46 normal individuals a population of threshold scores may be postulated having a mean critical fusion frequency of 82·1 interruptions per second with a standard deviation of 19·4 when the interrupted noise has a sound-time fraction of 0·90 and an intensity of 70 db *re* 0·000 2 dyne/cm^2. A.

612.858.76

7581. Sound level discrimination and variation of reference testing conditions. I. Pollack. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 474–80 (*May*, 1955).

The accuracy of discrimination of small changes in sound level was examined as a function of the magnitude, temporal, and dimensional aspects of the variation between two reference testing conditions. Precision of sound level discrimination declined as: the magnitude of the sound level difference between the two reference conditions increased and as the frequency of occurrence of shifting between the two reference conditions increased. Of lesser importance was the temporal interval between successive discriminations, variation in the audio-frequency of the reference signals, and the predictability of the to-be-presented testing conditions. The results are considered in terms of a preliminary analysis of psychological dimensions in auditory discrimination. A.

614.898 : 539.165 : 539.172.4

7582. Hazard due to beta radiation from fission products deposited on the ground after an atomic explosion. F. S. Goulding and G. Cowper. *Atomic Energy Canada Rep.*, *No.* 37, 11 *pp.* (*Jan.*, 1953).

Measurements of a P^{32} source on the ground, with a Geiger counter at height 100 cm, are used to determine the β-ray dose due to a surface contamination of fission products giving 100 r γ-ray dose. The β-ray energy spectrum is separated by Al filters into ranges with different penetrations into the skin, and the total dose (i.e. energy absorption) in 1 mm depth of skin is found by integration of concentric circles over a flat ground surface. In the absence of irregularities the β-ray dose is about $3\frac{1}{2} \times \gamma$-ray dose; any roughness or objects (walls, etc.) increase this ratio. F. T. Farmer

615.849

7583. A device for the measurement of dose as a function of specific ionization. H. H. Rossi and W. Rosenzweig. *Radiology*, **64**, *No.* 3, 404–11 (*March*, 1955).

A spherical proportional counter, filled with CH_4 at 3 cm Hg pressure, is described. An α-particle source can be brought to the surface of the sphere or

collimated and filtered by Al absorbers before reaching the sensitive volume. Total ionization = (specific ionization) × (path length in the gas volume). Particles of any given specific ionization will produce a triangular ionization pulse spectrum whose area is proportional to (pulse height) × (number of pulses), and the total pulse spectrum is a superposition of individual triangular spectra. Pulse heights are separated by a differential discriminating system and the spectrum is analysed for individual components by obtaining a counting rate for particles in each height group that travel through a major diameter of the counter. An Appendix treats mathematically the path length distribution in a spherical cavity. Further work with protons and neutrons is projected. D. V. MABBS

615.849

7584. Modification of electron filter to improve light localization of a cobalt-60 beam. J. E. RICHARDSON AND M. BRUCER. *Radiology*, **64**, *No.* 3, 398–403 (*March*, 1955).

With a Co^{60} beam therapy unit having a short source-to-skin distance, it is necessary to filter electrons produced in the collimating system. A thin Cd sheet is effective, as shown by experimental curves. A narrow slit is left round the periphery of the filter (mounted on Lucite) to enable the light field-localizer to be retained. It is arranged that the light source now delineates the edge of the geometrical beam and the width of the geometrical penumbra. D. V. MABBS

616–7 : 612.1 : 518.5

7585. Analogue computer for a.c. oximetry. W. PAUL. Note in *J. sci. Instrum.*, **32**, *No.* 7, 286 (*July*, 1955).

The computer is applied to the oximeter described in Abstr. 5264 (1953).

TECHNIQUE. MATERIALS 62/69

666.1.056.5 : 535.55

Optical stress measurements on glass–metal seals at high temperatures. *See Abstr.* 6972

PHOTOGRAPHY 77

77

7586. Science and applications of photography. Edited by R. S. SCHULTZE. *London: The Royal Photographic Society* (1955). 664 *pp.*

Proceedings of the International Conference held in London in September, 1953, on the occasion of the Centenary of the Royal Photographic Society of Great Britain. 150 papers are presented under group headings as follows: Emulsion technology; Chemical sensitizing; Optical sensitizing; Latent image theory; Photographic effects; Theory of processing; Properties of the developed image; Sensitometry and densitometry; Chemistry of non-silver halide processes; Photographic optics; Colour correction and colour masking; Investigations of colour materials and processes; Colour photography in practice; Kinematography; Photogrammetry, stereophotography; High-speed photography and kinematography; Radiography, autoradiography; Nuclear track photography; Medical, biological and forensic photography; Photomechanical processes; History, literature and documentation of photography; Photocopying techniques. For contents of some of the papers see individual abstracts.

771.35

7587. Color-correcting lens for underwater photography. E. M. THORNDIKE. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 7, 584–5 (*July*, 1955).

The lens consists of a plano-concave element cemented to a plano-convex element, and is used in front of the window in water. The power of the correcting lens is so nearly zero that it does not affect the focus of the camera lens. R. W. FISH

771.534.01

7588. A further contribution to the theory of photographic sensitivity. T. EVANS, J. M. HEDGES AND J. W. MITCHELL. *J. photogr. Sci.*, **3**, *No.* 3, 73–87 (*May–June*, 1955).

A summary of many experiments on the sensitization of large AgBr crystals with and without gelatin; on their chemical and photographic behaviour; and on the reactions of microcrystals in emulsions. Photographic sensitivity is discussed at length and is considered due to localized centres of crystal disorder, especially at surfaces where chemical sensitizers are mainly formed during the ripening process. Energy absorption produces halogen and Ag atoms at these centres. The halogen is removed by reaction with sensitizers, with Ag or Ag_2S, while the mobile Ag atoms form pairs ("latent sub-image") on which further Ag atoms form a stable latent image either on the surface or within the disordered structure of the sensitivity centre. Development proceeds readily at these points on account of the localized strain in the crystal. S. T. HENDERSON

771.534.55

7589. Some theoretical considerations on photographic graininess and granularity. J. H. WEBB. *J. Opt. Soc. Amer.*, **45**, *No.* 5, 379–88 (*May*, 1955).

Recent work by Jones and Higgins has led to an objective method for evaluating the granular structure of the developed photographic image by which materials of widely differing granularity can be ordered in correspondence with subjective graininess measurements. The present paper gives the theoretical calculations of statistical fluctuations of density and syzygetic density differences ($S\Delta D$) for simplified density patterns when scanned with varied size apertures. Average syzygetic density values, $\langle S\Delta D\rangle_{Av}$, *v.* density curves are derived first for square, checkboard density patterns and second for circular patterns containing uniform-size grains with random arrangement. By combining the experimental, threshold,

visual, gradient sensitivity curve ($\langle S\Delta D\rangle_{Av}$, *v.* density for critical aperture), obtained by Jones and Higgins, with theoretical curves of $\langle S\Delta D\rangle_{Av}$ *v.* density calculated here, it is shown how the graininess-density curve can be obtained. A.

771.534.556

7590. On the Eberhard effect at [with] different developers. With special regard to the influence of potassium bromide and sodium sulphite. N. HANSSON. *Ark. Astron.*, **1**, *Paper* 28, 393–410 (1954).

The effect has been studied by photometering the negative image of a standard illuminated wedge photographed in a copying-camera with a 25 cm Tessar lens at *f* 22. Two emulsions, Ilford Zenith, and HP3, and 18 different developers were investigated, using still and agitated development. The results, embodied in a series of tables and graphs, show that to minimize errors due to Eberhard effect the developer must (i) be highly concentrated; (ii) have a high concentration of KBr, and probably also a low concentration of Na_2SO_3; (iii) be effectively stirred throughout development. The proportion of metal to hydroquinone in M.Q. developers is unimportant so long as the developer is well-stirred. Ferro-oxalate developers are found to behave differently as regards the Eberhard effect. A bibliography of 28 references is appended. D. R. BARBER

771.535

7591. Regression of the latent-image centres. B. I. KAZANTSEV AND P. V. MEĬKLYAR. *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 70–6 (1955) In Russian.

Photographic plates were subjected to a 100-sec exposure, either at a stretch or in two instalments with an intervening interval of darkness; after development, the blackening was determined sensitometrically. It was found that the obtained results of the regression (fading) of both the latent-image centres (in thick-emulsion plates) and subcentres (in ordinary plates) do not tally with either of the two theories so far suggested, i.e. the oxidation theory and that involving the recombination of Ag atoms with Br. It was also found that Meĭklyar's [Abstr. 8739 (1951)] equation $\Delta\sigma/\Delta\sigma_0 = 1/(1 + at)^{\alpha}$ for the decay of photoconductivity in Ag halide crystals, when transformed into $N/N_0 = 1/(1 + N_0 k\tau)^{\alpha}$, where N and N_0 are the numbers of Ag atoms in a centre at the end and beginning of the time interval τ, respectively, and k and α are constants (varying from $\sim 0{\cdot}2$ to $\sim 0{\cdot}5$ in either equation), represents very accurately the sensitometric curves obtained. F. LACHMAN

778.3 : 778.5 : 616.12

7592. An improvement in cine densigraphy: the polydensigraph. M. MARCHAL AND M.-T. MARCHAL. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 17, 1728–30 (*April* 25, 1955) In French.

Apparatus is described for studying movements of the heart contour using 10 p.e. cells arranged about the shadow of the heart on an X-ray fluorescent screen. Each cell produces a trace on a common c.r. tube which is photographed on a cine film at 120 frames per sec; the film is then projected slowly for examination of relative movements of points in the heart. The technique is to be used in conjunction with ECGs for investigating heart pathology. F. T. FARMER

778.33

7593. Technique of microautoradiography for metal specimens. R. C. PLUMB. *Rev. sci. Instrum.*, **26**, *No.* 5, 489–93 (*May*, 1955).

A microautoradiographic technique which may be used with aluminium alloys is described. It is shown capable of producing a resolution of at least 9μ with X-radiation and supplying quantitative information as to the distribution of radioactive material in a metallurgical structure. A.

778.34

7594. A contribution to the systematic study of photographic emulsions used in nuclear physics. J.-P. LONCHAMP. *Ann. Phys.* [*Paris*] **10**, 201–58 (*March–April*, 1955) In French.

A thesis wholly concerned with nuclear emulsions and mainly with the range–energy relation, the latter subject being treated very systematically. The various factors on which the relation might be thought to depend, such as humidity, development and chemical composition are all fully discussed. Studies of the reactions: $Li^6(n,\alpha)\,H^3$ and $B^{10}(n,\alpha)\,Li^7$ have enabled the author to give two points on the range-energy curve for α-particles and one on that for protons. Theoretical calculations have been made on the range-energy curves for ions of charge greater than 2, in particular, it has been calculated for C_6^{12} ions of up to 120 MeV. The agreement with the few known experimental points is satisfactory. As an example of the use of the photographic plate technique the total cross-section for the reaction $N^{14}(n,p)C^{14}$ at thermal energies was measured to be 1·80 barn. A theoretical study of the thickness of tracks caused by heavy fragments from cosmic-ray stars and from fission has also been made. The calculated diminution in thickness as a fragment nears the end of its range due to the effective reduction in charge by electron capture is in good agreement with that found experimentally. D. J. PROWSE

778.34

7595. A simple arrangement for the rapid measurement of gaps. G. BARONI AND C. CASTAGNOLI. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 364–8 (1954) In French.

A high-speed method has been developed for the measurement of gaps in emulsion tracks. The stage is moved mechanically at a uniform rate, and a push-button, connected to a simple electronic circuit, is pressed by the observer during the passage of a gap. The circuit is capable of recording gap numbers, gap densities and integral or differential gap length. P. ROTHWELL

778.34

7596. Mass determination on steeply dipping tracks in emulsion block detectors. S. BISWAS, E. P. GEORGE, B. PETERS AND M. S. SWAMY. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 369–73 (1954).

The customary methods for deducing mass from steeply dipping tracks using multiple scattering and range or grain density give unreliable results because of emulsion distortions. The effect of such distortions can be completely eliminated if the scattering is estimated from third or higher order co-ordinate differences. Good mass determinations have been made

on a small sample of proton tracks with dip angles between 32 and 52°. P. ROTHWELL

778.34

7597. The effect of processing on the estimation of ionisation by blob-counting. C. O'CEALLAIGH. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 412–15 (1954).

The limitations of the blob-counting method and its dependence on the degree of development and fixing are discussed. The results of a theoretical investigation are presented graphically for a range of conditions varying from slight to excessive development. These graphs display predicted variations of blob density with grain density, mean gap length and proton range in G5 emulsions. P. ROTHWELL

778.34

7598. A new method for mass measurements of fast, charged particles. S. ROSENDORF AND G. YEKUTIELI. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 416–18 (1954).

Describes a method of measuring the mass of particles, whose tracks do not stop in the emulsion, depending on the variation of grain density *v.* range. It is stated that the method is only useful if $g^* > 1 \cdot 3g_{pl}$ the available track length is >6 cm and the plates are uniformly developed. Measurements on two π-meson tracks are given. P. ROTHWELL

778.34

7599. Recommendations for the standardization of measurements in photographic emulsions. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 474–9 (1954).

778.34

7600. Latent image fading of proton tracks in Ilford G-5 emulsion. G. LEIDE. *Royal Photographic Society International Conference* [*London*] 427–9. See Abstr. 7586 (1955).

The fading of the latent image of slow protons was investigated in Ilford G-5 emulsion of 200μ thickness. A photoelectric method was used. The emulsions were exposed in a cyclotron to protons in two directions at right angles to one another with an interval of three months. During this time the plates were stored at different relative humidities and temperatures. It was found that long-time fading, e.g. in cosmic-ray work, can be prevented by keeping the plates at 3°C. A.

778.34

7601. On the photometry of nuclear tracks. L. VAN ROSSUM. *Royal Photographic Society International Conference* [*London*] 430–4. See Abstr. 7586 (1955).

The different physical quantities are enumerated which may be utilized in measuring the grain density of nuclear tracks in photographic emulsions. The different modes of operation according to which the photometric measurements may be carried out are indicated. Considering the various ranges of specific ionization it is then discussed which mode of operation measures best the quantity most sensitive to a variation of ionization. Finally, the chief corrections are indicated which have to be applied to the measurements, and their influence on the choice of the mode of operation. The apparatus is described and illustrated. A.

778.34

7602. Use of nuclear track emulsions for detecting excited states of α-emittors. G. ALBOUY. *Royal Photographic Society International Conference* [*London*] 435–40. See Abstr. 7586 (1955).

General indications are given concerning the use of emulsions sensitive to electrons for the study of radiations caused by internal conversion following emission of α-particles. A.

778.34

7603. Some experiments on the development of nuclear emulsions for the discrimination of particles at low energies. R. CHASTEL AND A. BERNET. *Royal Photographic Society International Conference* [*London*] 441–4. See Abstr. 7586 (1955).

The aim of this work is improved discrimination, particularly between particles of short range with the same charge but different masses. With strictly homogeneous development in view, a study has been made of the under-development of Ilford C.2 emulsion at a range of pHs, and the pH needed to give uniform development as a function of emulsion thickness; amidol-bisulphite developer has been used. Further investigations in progress are concerned with the effect of development conditions on the shape of the developed grains. A.

778.34

7604. The diffusion of radioactive rare gases in nuclear emulsions. L. VIGNERON, R. CHASTEL AND J. GENIN. *Royal Photographic Society International Conference* [*London*] 445–6. See Abstr. 7586 (1955).

One part of the atoms of rare gases which are produced within a nuclear emulsion during a series of radioactive decays remain fixed in the crystals of silver halide, whilst another part is free to diffuse in the gelatin. This phenomenon changes the proportions of single tracks and stars with 2, 3, 4 or 5 branches; it must be taken into account when emulsion is used to estimate radioactivity and in studies of low energy cosmic-ray stars. A.

778.34

7605. The characteristics of tracks in nuclear research emulsions. A. J. HERZ AND G. DAVIS. *Austral. J. Phys.*, **8**, *No.* 1, 129–35 (*March*, 1955).

Formulae are derived giving the dependence of the blob, grain and gap densities, the total gap length, and the mean gap width in the tracks of charged particles as function of the probability of making a silver halide crystal developable. The growth of the grains during the development process is taken into account. The expressions found are suitable for use in discussions of the effects of changes in emulsion properties, and they show clearly the differences between the various methods of determining the rate of energy loss from the track characteristics. There is good agreement with experiment for both G5 and C2 emulsion. A.

778.34

7606. Influence of liquid drying agents on the gelatine of photographic emulsions used in nuclear physics. L. VIGNERON, J. GÉNIN AND R. CHASTEL. *J. Phys. Radium*, **16**, *No.* 3, 179–82 (*March*, 1955) In French.

It has been noted previously that the ranges of

particles emitted by radioactive ions which had been introduced into nuclear emulsion were sometimes anomalously high. It is shown that this was due to the action of the drying agent used to remove the water from the emulsion (and so leaving the solute in the emulsion). When the emulsions are dried in the air or *in vacuo* no anomaly is observed, but when alcohol is used the horizontal projections of the particle tracks are found to be some 12% and in the case of acetone some 35% too long. This is thought to be due to the alcohol or acetone leaving the gelatine, and hence the emulsion, in a porous state and so decreasing the stopping power. When it is eventually processed the final thickness is that of a normal processed emulsion, so the vertical projections of the tracks are unaffected. Measurements made on the dimensions and density during the drying process confirm the porous nature of an alcohol-dried unprocessed emulsion. D. J. PROWSE

778.34

7607. Anomalies in the diffusion of radon in "dry" photographic gelatine emulsions. The possible existence of two forms of gelatine. L. VIGNERON, J. GÉNIN AND R. CHASTEL. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 13, 1423–5 (*March* 28, 1955) In French.

The frequency of 1, 3 and 4 prong stars has been determined in a number of Ilford C2 nuclear emulsions impregnated with radium. About 45% of the radon nuclei produced by the decay of the radium are trapped in halide crystals, the others are produced in the gelatine and are free to diffuse. The diffusion varies rather randomly from plate to plate and it is thought that this is due to the gelatine existing in two possible forms, first in an unstable form "α" in which radon cannot easily diffuse, then transforming after a variable time to a more stable form "β" with a higher diffusion coefficient. D. J. PROWSE

778.34

7608. Measurement of ionization in nuclear emulsions. P. H. FOWLER AND D. H. PERKINS. *Phil. Mag.*, **46,** 587–610 (*June*, 1955).

The gap-length distribution along the tracks of ionizing particles in nuclear emulsions has been investigated, and shown to be exponential for all values of specific ionization. The coefficient of the exponential, g, is suggested as the most useful measure of the ionization. In the first part of the paper, practical visual methods of measuring g are discussed. Accuracies not far inferior to the maximum possible are obtained by counting the small proportion of gaps of lengths exceeding two or three times the average value. The ratio of the coefficient g in a given track, to that in the track of a relativistic electron, is shown to be independent of degree of development, for particles below six times plateau ionization. In the second part of the paper, a detailed model is proposed, which is capable of explaining the dependence of g on the velocity and charge of the ionizing particle, and on the development and sensitivity of the emulsion. A.

778.34

7609. A method for stripping nuclear emulsions from their glass supports and remounting them. C. DAHANAYAKE. Note in *Nuovo Cimento* (*Ser.* 10) **1,** *No.* 6, 1251–4 (*June*, 1955).

The stripping is effected by immersing the plate in a weak solution of hydrofluoric acid in sodium acetate buffer. After careful washing the remounting is carried out as in the case of new stripped emulsions. A.

778.34 : 535.823.5

7610. Stage noise and spurious scattering. Reversing sagitta method. J. K. BØGGILD AND M. SCHARFF. *Nuovo Cimento Suppl.*, **12,** *No.* 2, 374–80 (1954).

Using a reversing sagitta method, measurements of stage noise have been made on two Leitz Ortholux microscopes and on one of the new Koristka microscopes (M.S.2). The track of a heavy primary and a scratch made on a glass plate by a grating machine were used in the measurements. The method does not require any refined optical equipment. P. ROTHWELL

778.34 : 621.396.96

7611. Signal to noise improvement and the statistics of track populations. N. WAX. *J. appl. Phys.*, **26,** *No.* 5, 586–95 (*May*, 1955).

A treatment of the population statistics of signal and of noise patterns, or tracks, is given. Some idealized and abstract models of tracking procedures are studied; the models are intended to represent the processes encountered in radar tracking and in scanning nuclear emulsions for tracks. The equilibrium track population, the age distribution of the population at equilibrium, and a signal-to-noise improvement factor are obtained for each of the models considered. It is shown that the equilibrium population can be kept to reasonably small values, and the signal-to-noise ratio improved, if effective methods are used to eliminate deteriorating tracks. A.

778.37

7612. Use of an electron-optical converter for photographing high-speed processes. M. P. VANYUKOV AND E. V. NILOV. *Zh. tekh. Fiz.*, **24,** *No.* 7, 1209–18 (1954) In Russian.

An electron-optical convertor with electrostatic focusing, type AEG, was used as a high-speed shutter actuated by short voltage pulses. Good reproduction was obtained with an impulse lasting 0·4 μsec. At an instantaneous illumination of 10^6 lux on the photocathode a redistribution of the brightness of the reproduction takes place, and its dimensions vary with the illumination level. These phenomena are associated with the formation of a space charge in the valve and the potential relief on the photocathode. Various stages of a spark discharge in argon were photographed with exposures of 0·4–2 μsec. B. F. KRAUS

778.37 : 537.523.4

7613. A catadioptric camera for ultra-violet spark photography. J. DYSON. *J. sci. Instrum.*, **32,** *No.* 7, 272–5 (*July*, 1955).

In order to perform "time-resolved" photography of long sparks on a strip of film placed inside a flywheel rim, an optical system has been devised based on a nearly concentric mirror-pair similar to that used in a

conventional reflecting microscope. A field-flattening lens is used together with two lenses to correct the chromatic defects introduced by the field-flattener. The nominal aperture is $f/1 \cdot 85$ with a focal length of 72 mm. Simultaneous photographs of the same discharge are shown taken by a $f/4 \cdot 5$ quartz-rocksalt achromat and the system described above. These show the advantage to be gained by using the above system. A.

778.6

7614. Subtractive color photography: spectral sensitivities and masks. W. T. Hanson, Jr and W. L. Brewer. *J. Opt. Soc. Amer.*, **45**, *No.* 6, 476–81 (*June*, 1955).

In linear photographic masking theory it is assumed that the cyan, magenta and yellow dyes in the processed film are deposited in amounts which are linear functions of the logarithm of each of the red, green and blue exposures. Metameric pairs of colours will be reproduced alike in the photographic process only if the spectral sensitivities of the red-, green- and blue-exposure emulsions conform to a set of visual colour-mixture curves. Optimum colorimetric reproduction is obtained through utilization of the combination of colour-mixture curves and photographic masks, relating due amounts to exposure, which minimize colorimetric reproduction errors. It is shown that significant changes in the choice of colour-mixture curves may be largely compensated for by corresponding changes in the masks. Optimum choices of masks depend in part upon the gamut of colours to be reproduced. Emulsion spectral sensitivities departing from colour-mixture curves may also yield essentially equivalent colorimetric reproduction provided that the masks are suitably chosen. A.

778.6

7615. Subtractive color reproduction: evaluation of the actual color-reproduction equations for a color process. W. R. J. Brown. *J. Opt. Soc. Amer.*, **45**, *No.* 7, 539–46 (*July*, 1955).

The requirements for a photographic system to reproduce the chromaticities of selected colours can be described by a set of equations. These equations relate the amounts of dye needed in the reproduction to the exposure densities of the original colours. These equations have been called colour-reproduction equations by Brewer, Hanson, and Horton. These colour-reproduction equations have been computed for a negative-positive colour system. The equations state the requirements placed on a colour system if it is to reproduce the chromaticities of the original. A similar set of colour-reproduction equations can be computed which describe the actual performance of the colour system. These actual colour-reproduction equations are established by measuring the actual amount of dye produced in a process when reproducing a colour chart. These amounts of dye are related to the exposure densities of the original colours. The required and actual colour-reproduction equations for a negative-positive colour system are compared. The similarity between these sets of equations show how well a modern negative-positive colour system fulfills conditions of good colour reproduction. A.